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Bryntesen et al.

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(54) **APPARATUS, COMPONENTS, METHODS AND SYSTEMS FOR USE IN SELECTIVELY TEXTURING CONCRETE SURFACES**

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B24C 5/04 (2006.01)
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(52) **U.S. Cl.**
CPC ***B24C 3/062*** (2013.01); ***B24C 1/04*** (2013.01); ***B24C 1/06*** (2013.01); ***B24C 3/32*** (2013.01);
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(58) **Field of Classification Search**
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(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,882,541 A 10/1932 Billman
2,387,193 A * 10/1945 Swenarton B24C 1/086 134/36

(Continued)

FOREIGN PATENT DOCUMENTS

DE 39 27 601 A1 3/1991
EP 0 645 214 A1 3/1995
EP 2 952 310 A1 9/2015

OTHER PUBLICATIONS

EcoQuip Vapor Abrasive Blast Equipment, Graco Inc., 7 pages (Revised Dec. 2014).

(Continued)

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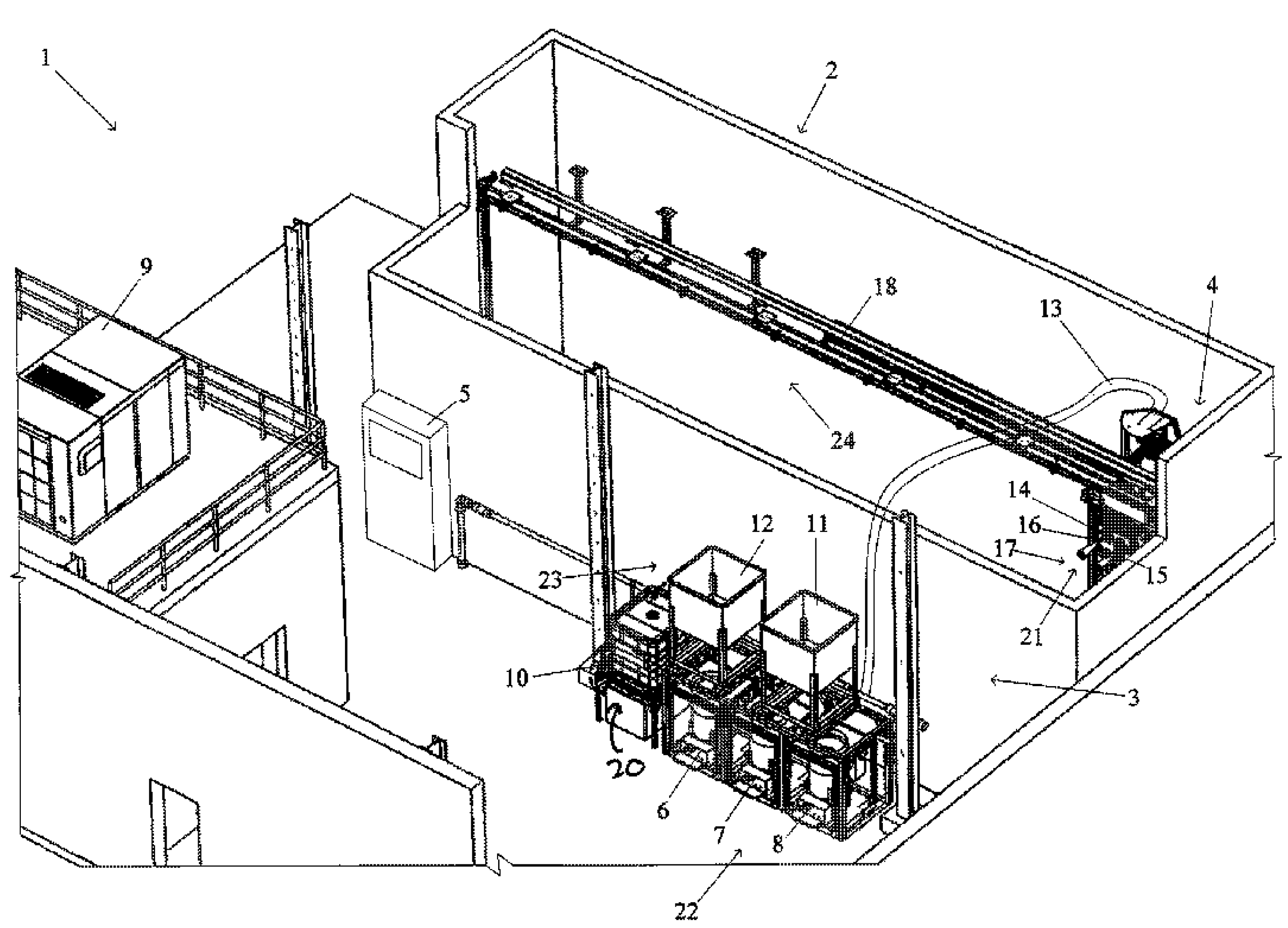
(57) **ABSTRACT**

Apparatuses, components, methods, and techniques for selectively texturing concrete surfaces are provided. An example method of providing a surface portion of an architectural precast concrete wall panel with an abraded texture is provided. The method includes a step of spraying a surface portion of an architectural precast concrete wall panel with an aqueous-based particulate abrasive mixture under conditions adequate to at least partially abrade the surface portion. An example sprayer system for abrading a concrete surface is also provided. The system includes an aqueous-based particulate abrasive mixture dispenser including a spray nozzle arrangement. The system also includes a material communication assembly in abrasive flow communication with the aqueous-based particulate abrasive mixture dispenser. The system also includes a dispenser positioning arrangement.

17 Claims, 16 Drawing Sheets



(51) **Int. Cl.**

B24C 7/00	(2006.01)
B24C 11/00	(2006.01)
E04B 1/04	(2006.01)
E04G 21/00	(2006.01)
B24C 1/04	(2006.01)
B24C 1/06	(2006.01)
B24C 3/32	(2006.01)

(52) **U.S. Cl.**

CPC ***B24C 5/04*** (2013.01); ***B24C 7/0023*** (2013.01); ***B24C 7/0038*** (2013.01); ***B24C 11/00*** (2013.01); ***E04B 1/04*** (2013.01); ***E04G 21/00*** (2013.01)

(58) **Field of Classification Search**

CPC . B24C 11/00; E04B 1/04; E04B 21/00; E03G 21/00

USPC 451/40

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,298,052	A *	1/1967	Wolfe	A47L 1/02	15/103
3,550,321	A	12/1970	Dye, Jr.		
4,199,358	A *	4/1980	Parsons	B24C 1/04	101/129
4,703,591	A *	11/1987	Herrington	B24C 1/045	451/40
5,042,208	A *	8/1991	Richardson	B23Q 9/0014	451/354
5,240,503	A	8/1993	Levy et al.		
5,367,841	A *	11/1994	Smith	B24C 3/062	451/87
5,586,927	A	12/1996	Herbert		
5,709,587	A *	1/1998	Shaffer	B24B 1/00	451/38
5,716,261	A *	2/1998	Watkin	B24C 3/062	451/75
5,772,496	A *	6/1998	Kurtz	B24B 19/26	451/296
6,092,517	A *	7/2000	Schanel	E04F 21/16	125/23.01
6,675,548	B2 *	1/2004	Bristol	B24C 1/06	239/11
6,997,780	B2	2/2006	Pieper		
8,298,347	B2 *	10/2012	MacNeil	B08B 3/024	134/172
8,790,163	B2 *	7/2014	Ke	E04F 21/32	15/49.1
8,894,467	B2 *	11/2014	Santure	B24C 3/04	451/2
9,393,672	B2	7/2016	Eliason		
9,744,644	B2 *	8/2017	Spires	B24C 1/06	
9,827,650	B2 *	11/2017	Santure	B24C 3/04	
2008/0261493	A1	10/2008	Fahnle et al.		
2010/0003894	A1 *	1/2010	Miller	B24C 1/04	451/5
2010/0215907	A1	8/2010	Spires		
2014/0170937	A1	6/2014	Sugimoto et al.		
2015/0111473	A1 *	4/2015	Geyer	B24C 1/10	451/40

OTHER PUBLICATIONS

International Search Report and Written Opinion for Application No. PCT/US2017/045099 dated Oct. 25, 2017.

* cited by examiner

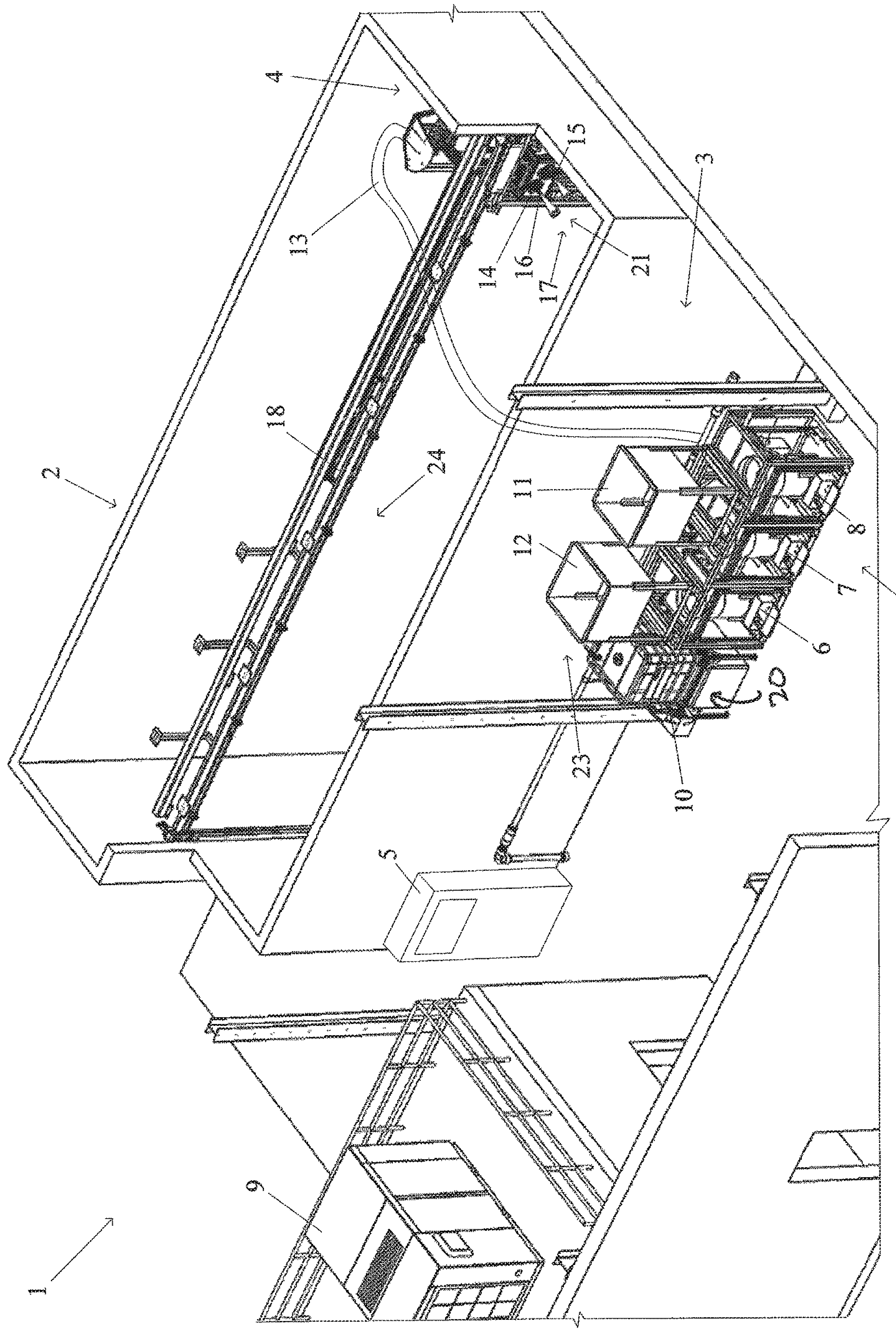


FIG. 1

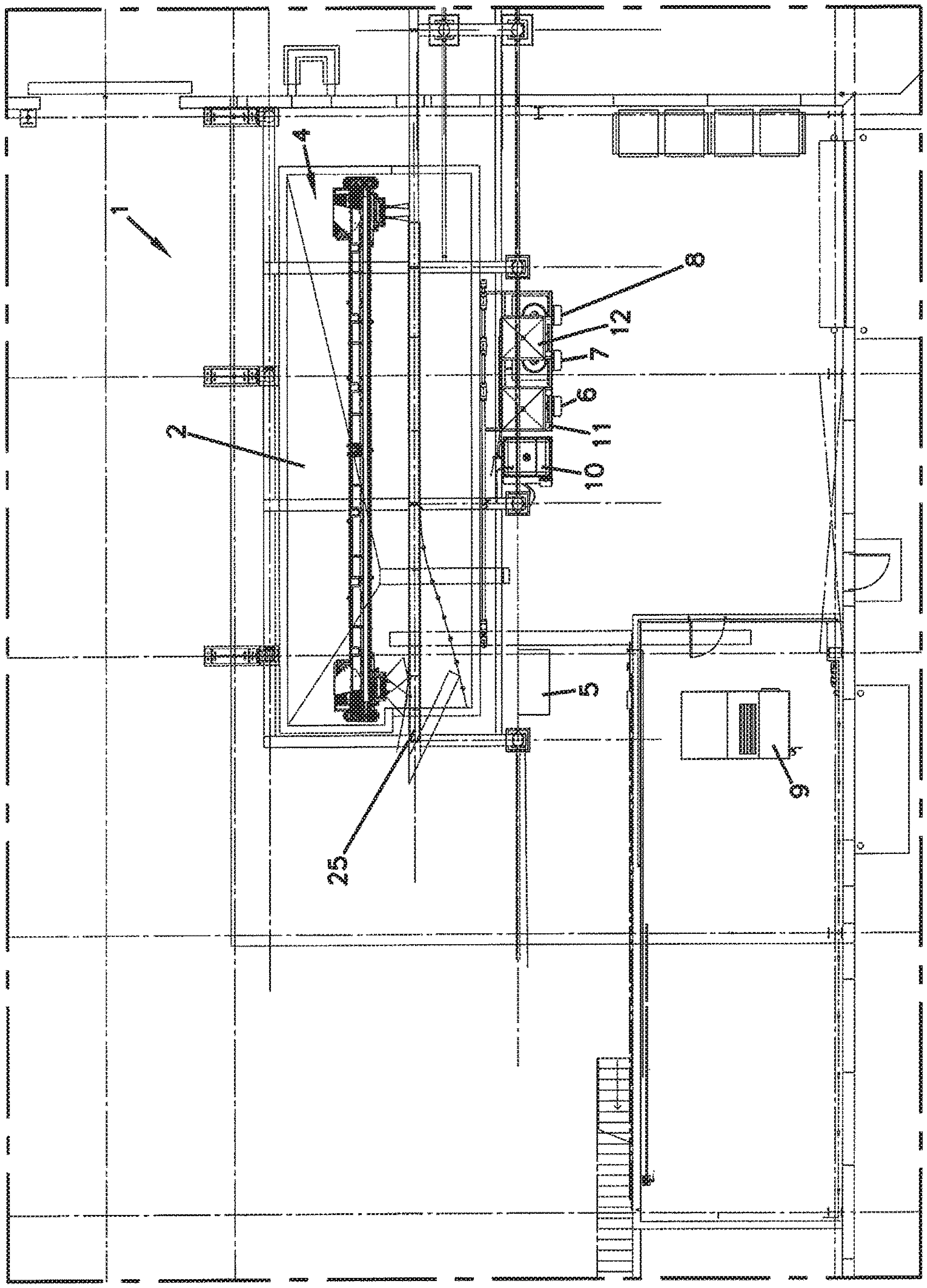


FIG. 2

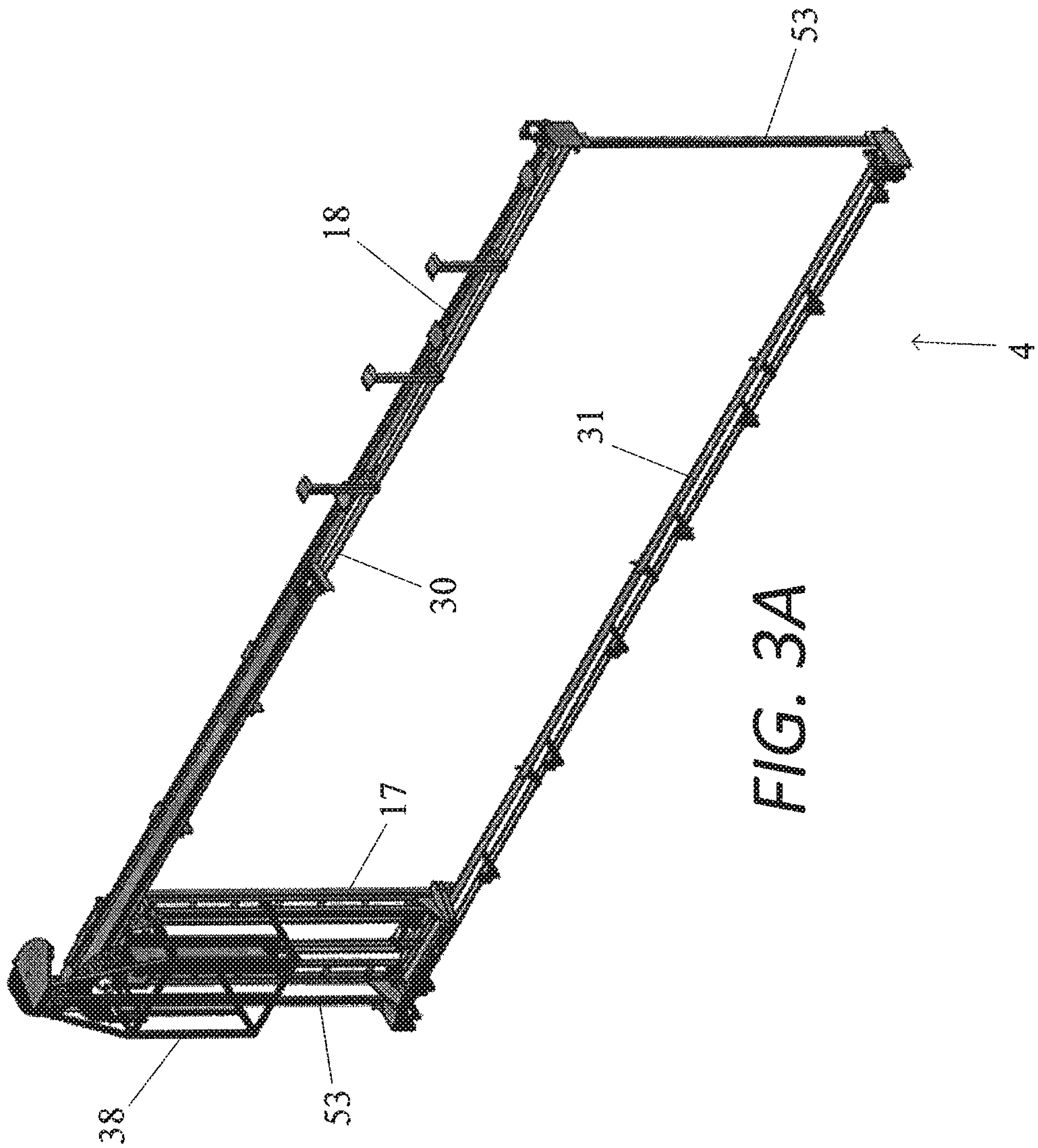


FIG. 3A

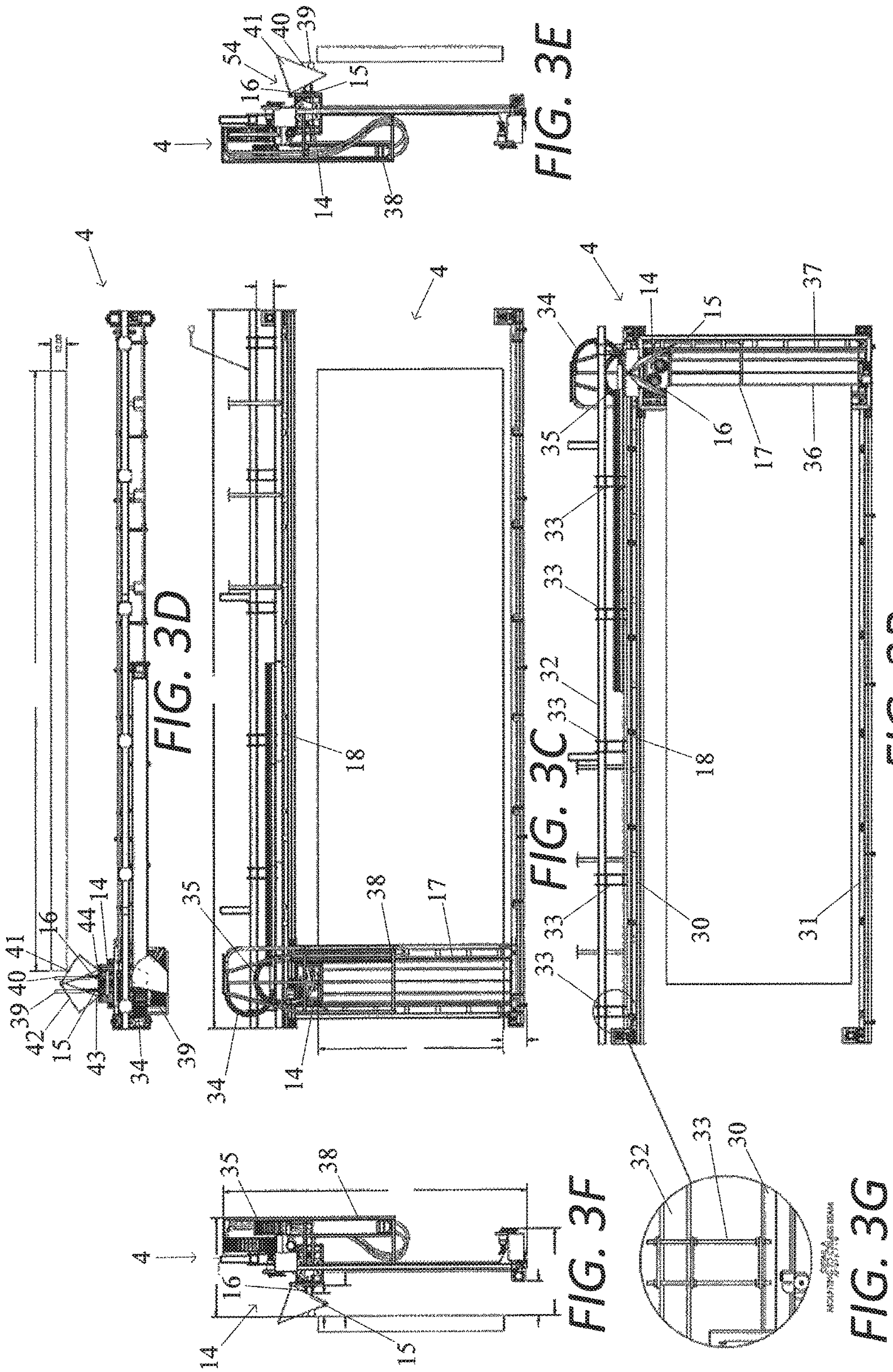


FIG. 3B

FIG. 3C

FIG. 3D

FIG. 3E

FIG. 3F

FIG. 3G

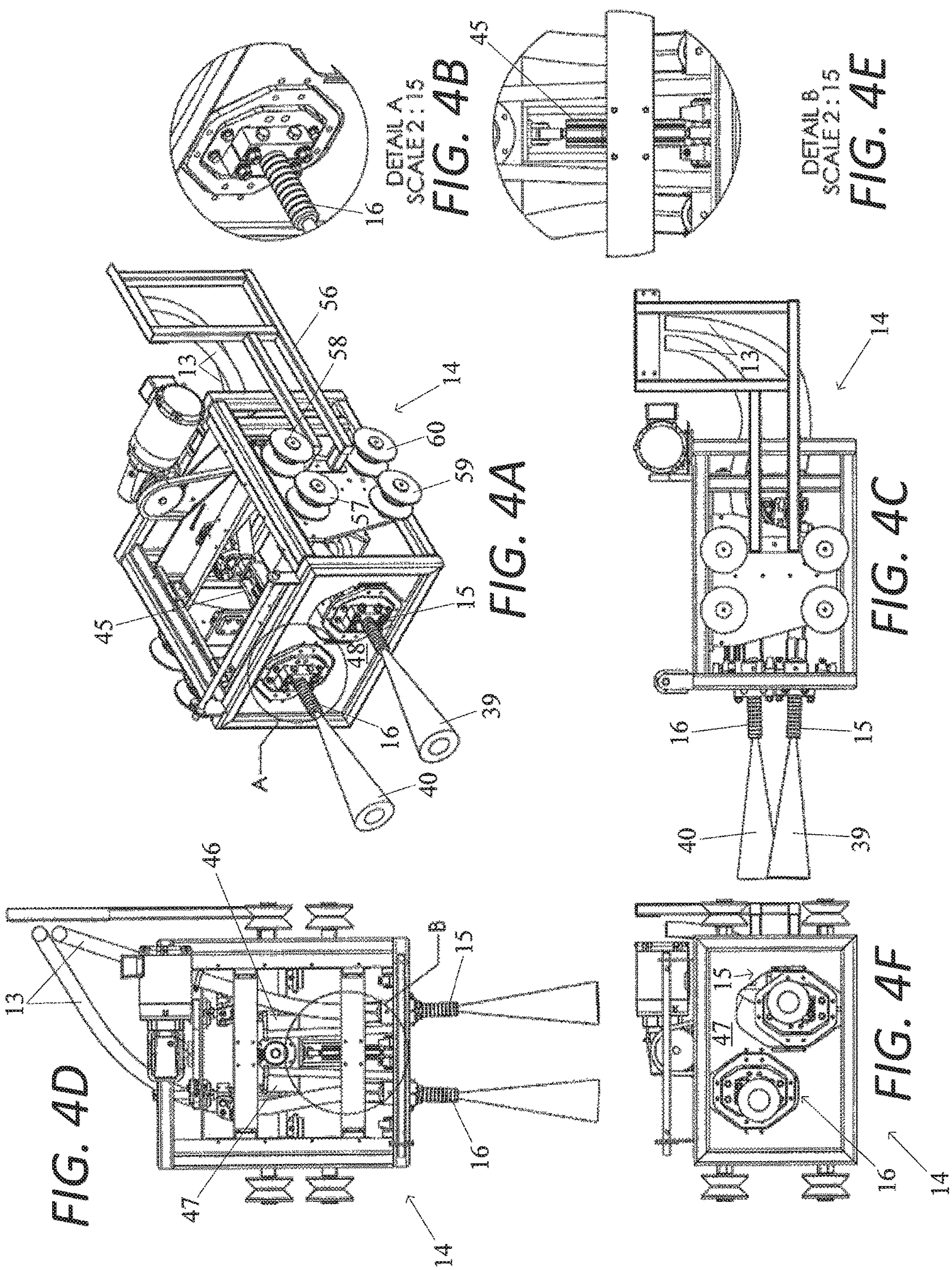


FIG. 4A

FIG. 4B

FIG. 4C

FIG. 4D

FIG. 4E

FIG. 4F

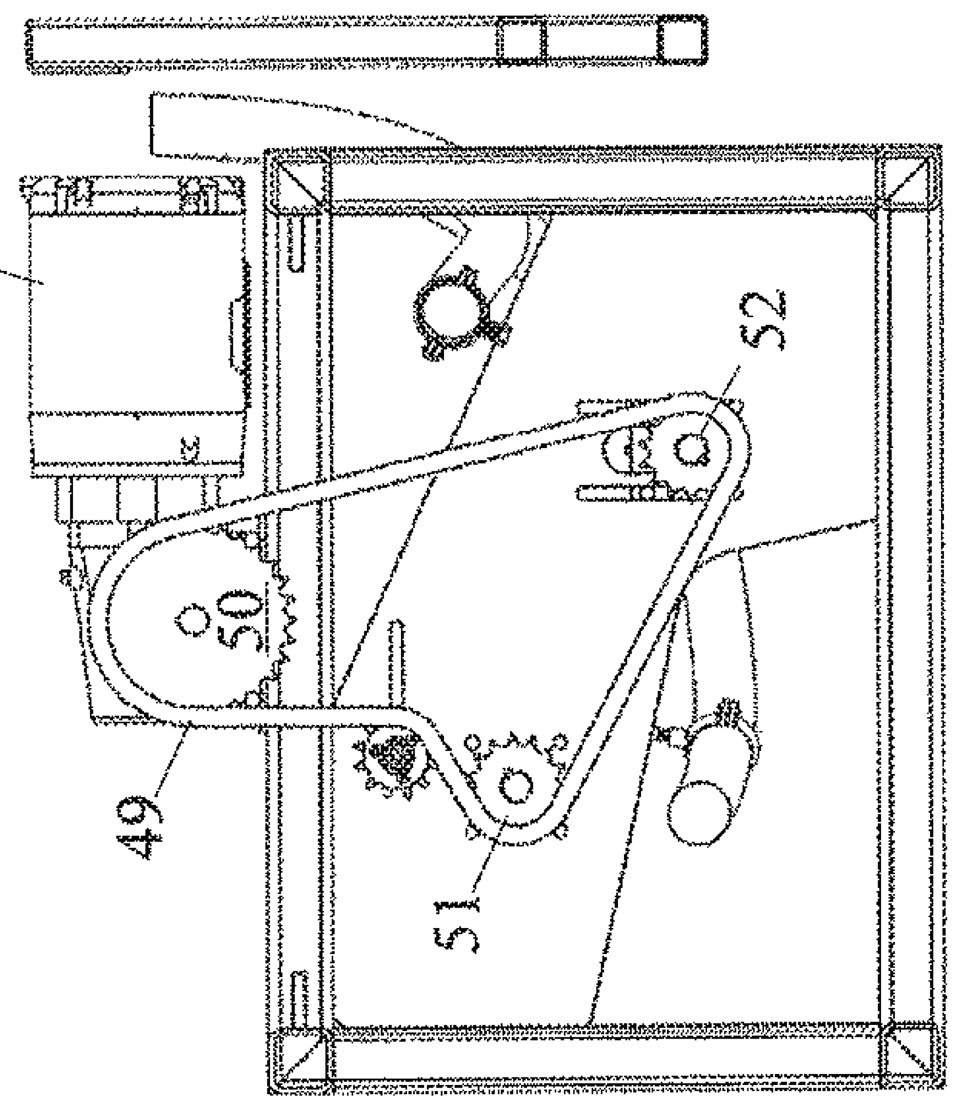


FIG. 5D

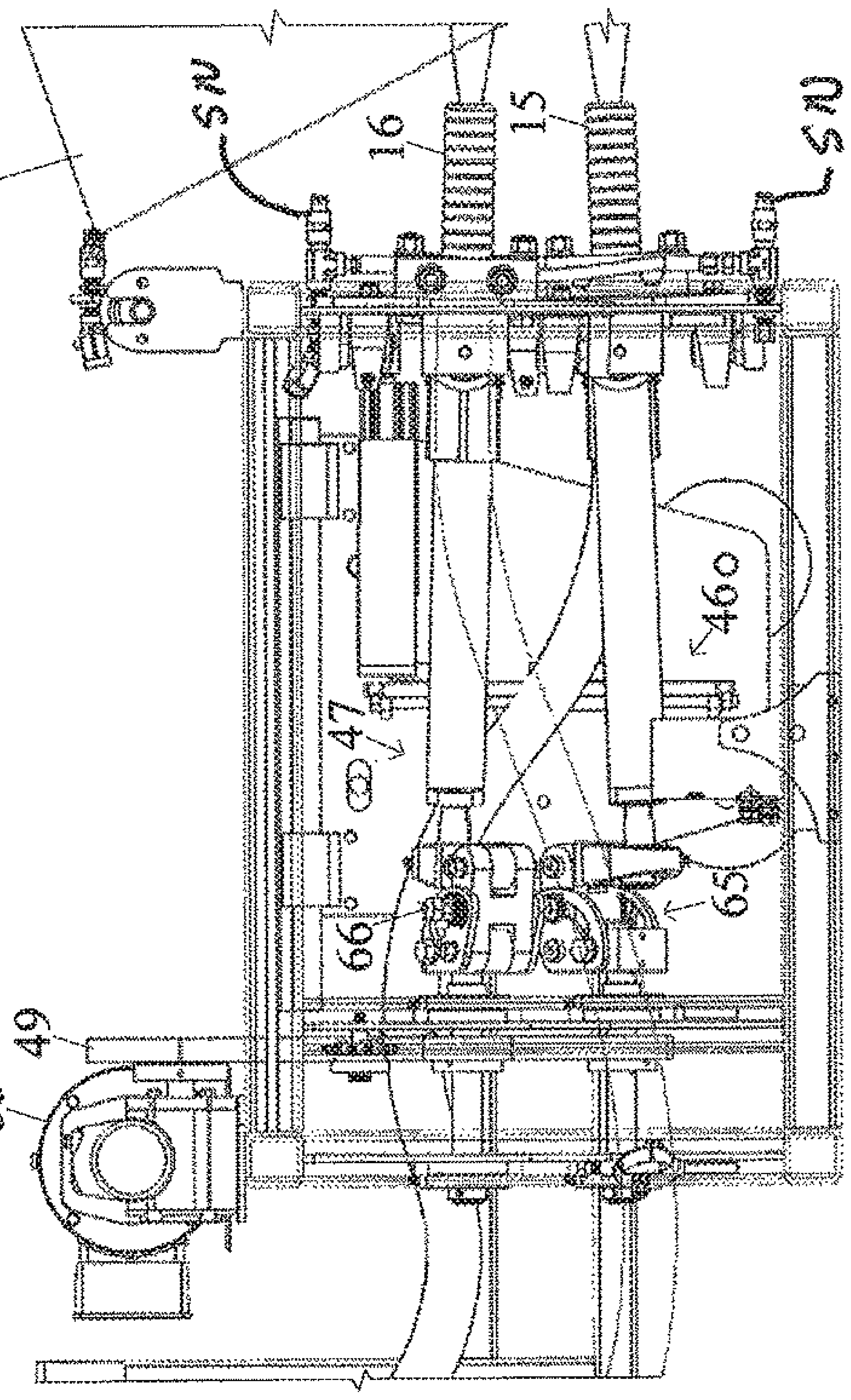


FIG. 5E

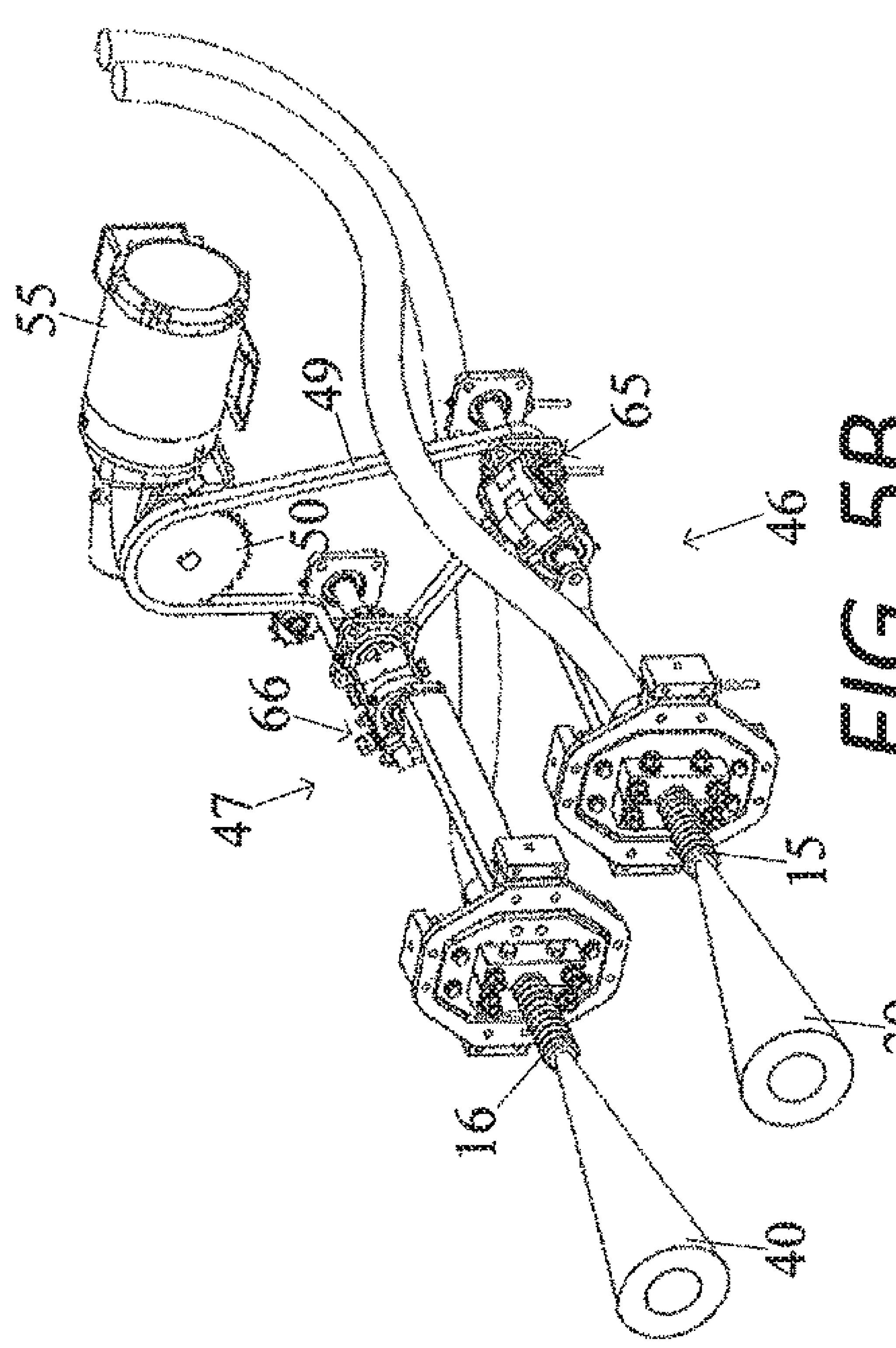


FIG. 5B

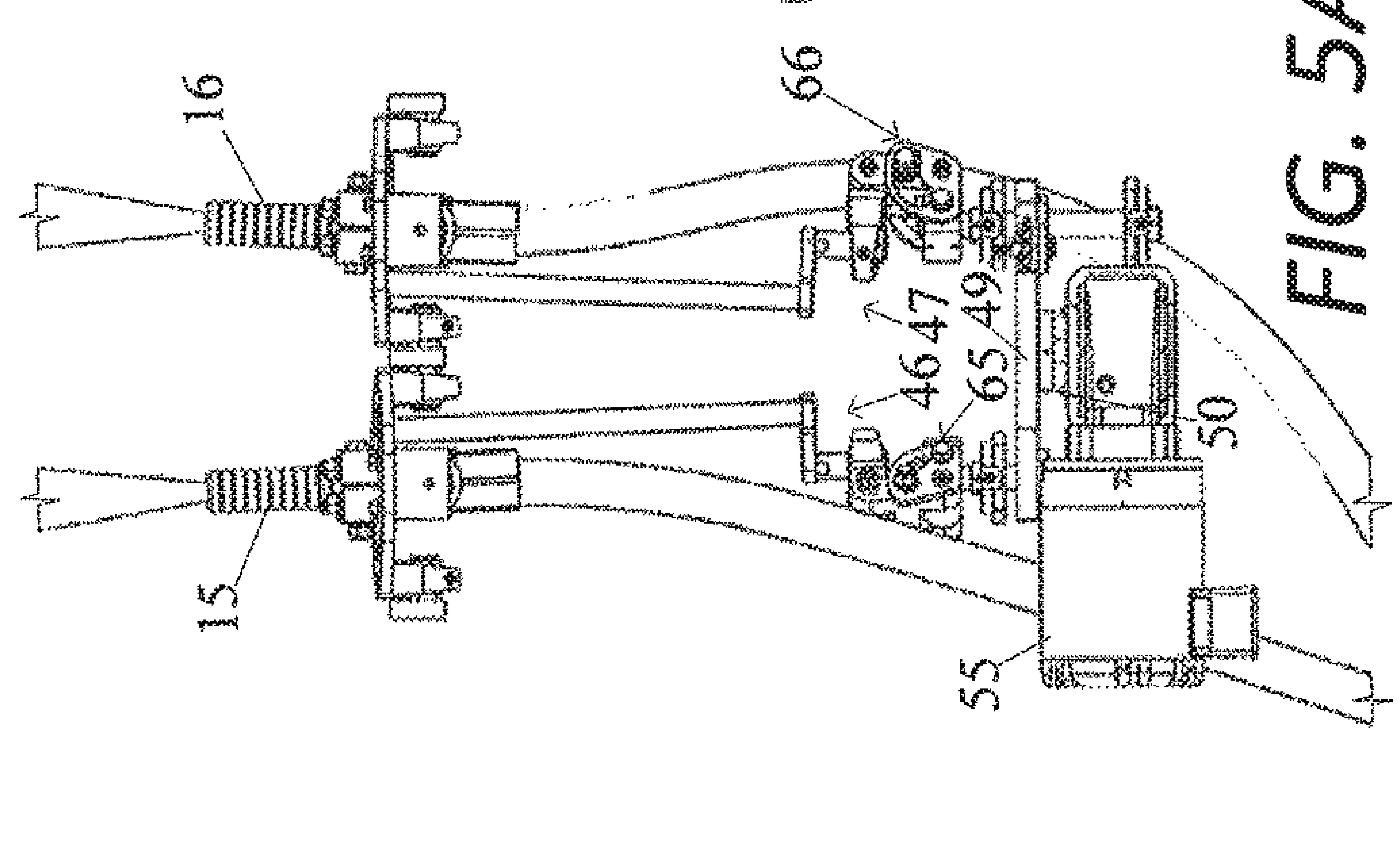


FIG. 5A

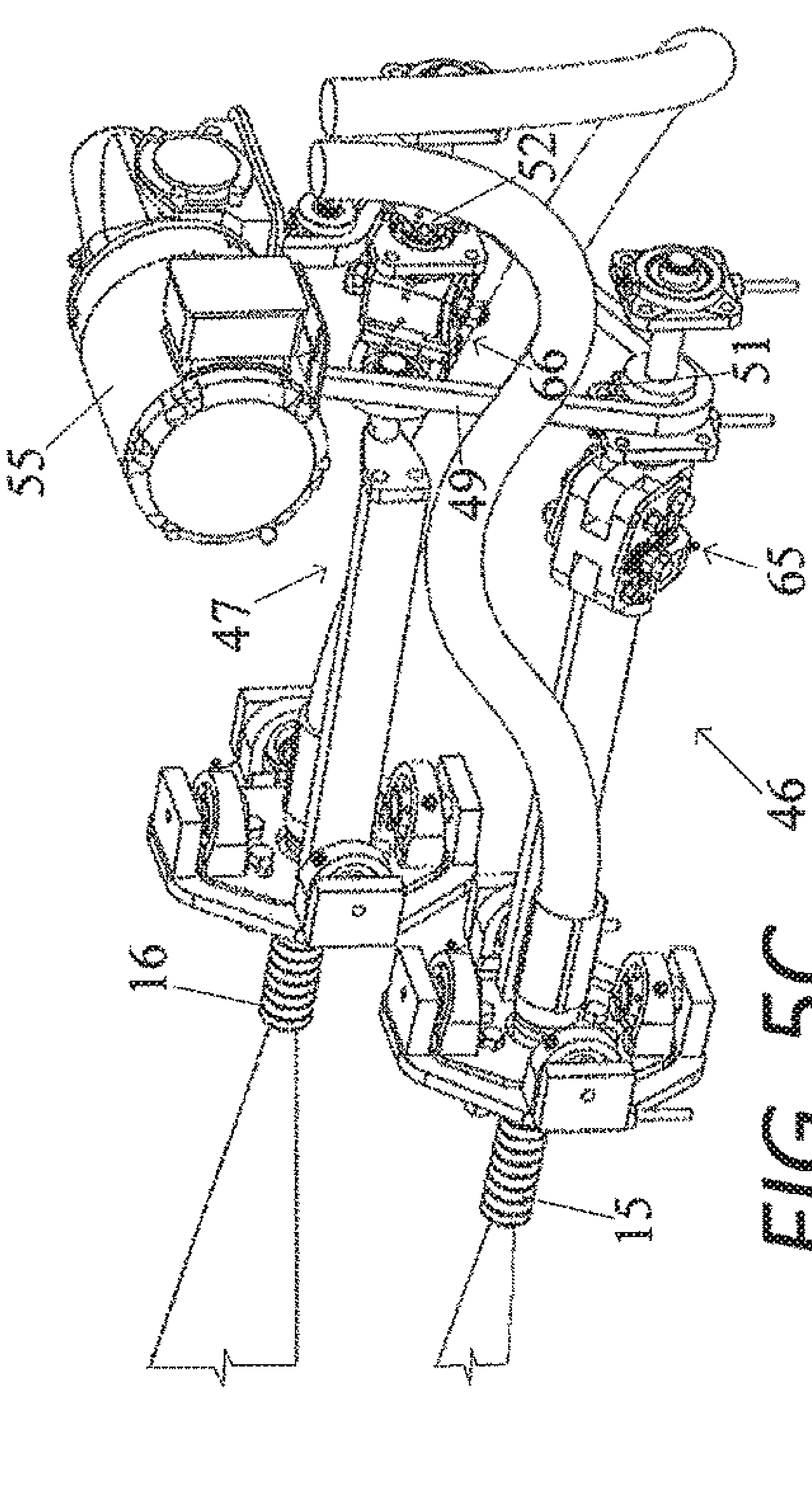


FIG. 5C

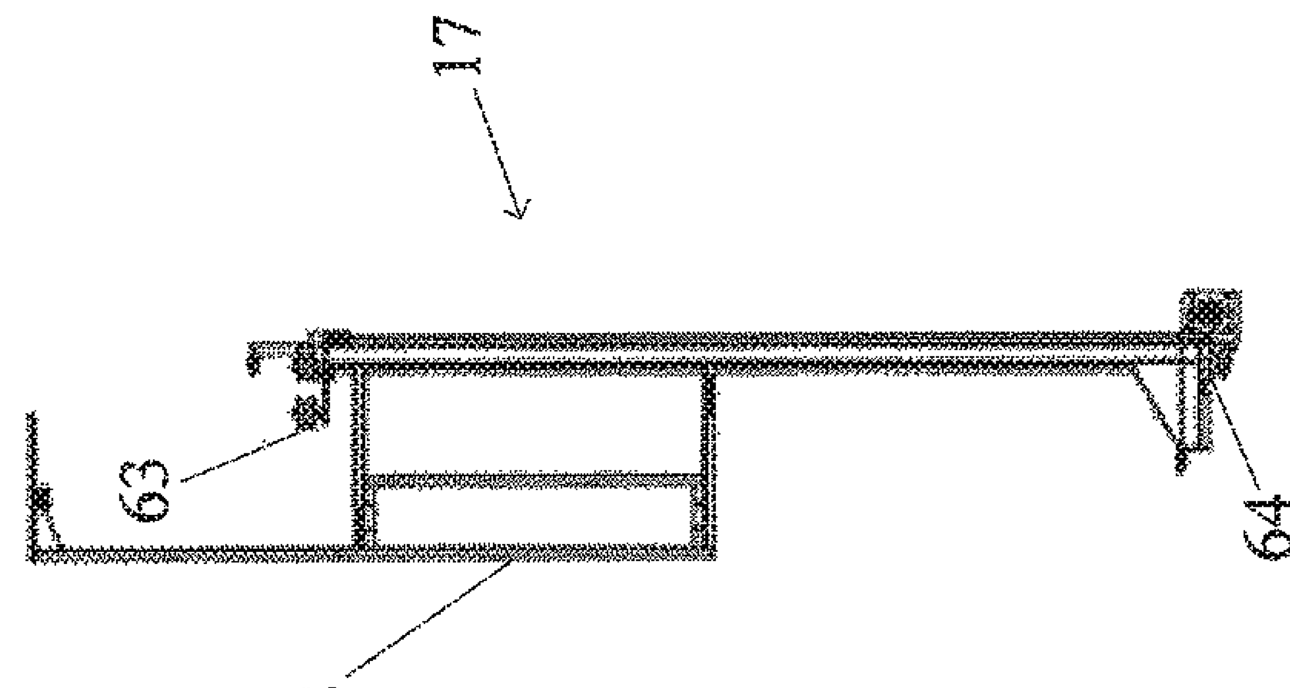


FIG. 6D

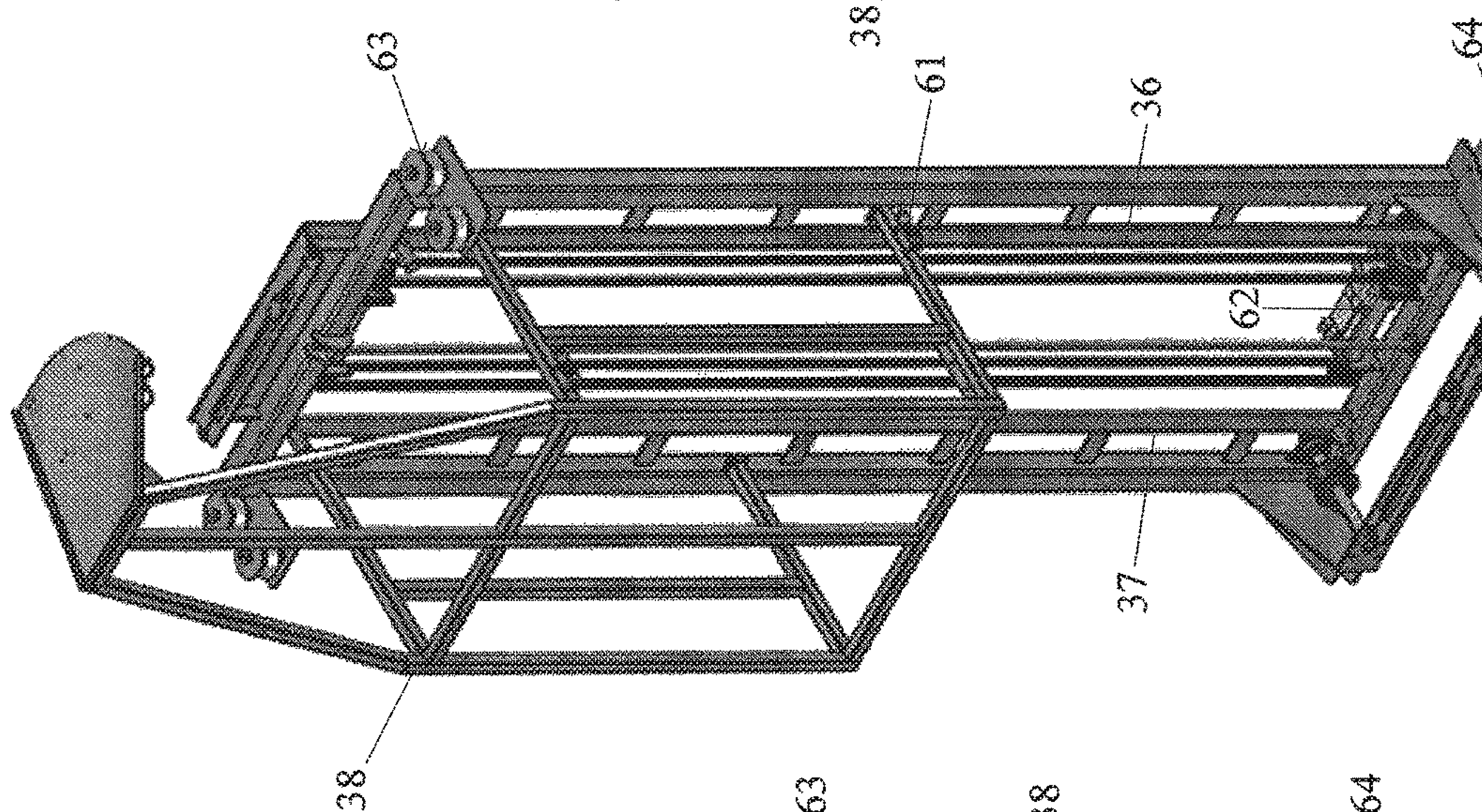


FIG. 6A

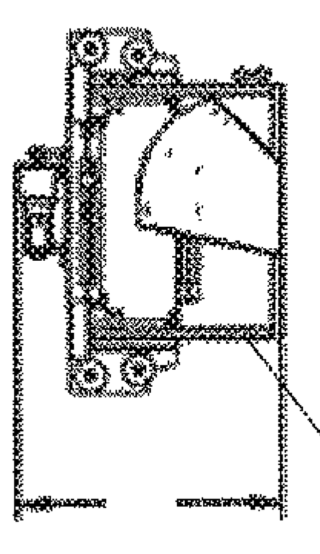


FIG. 6C

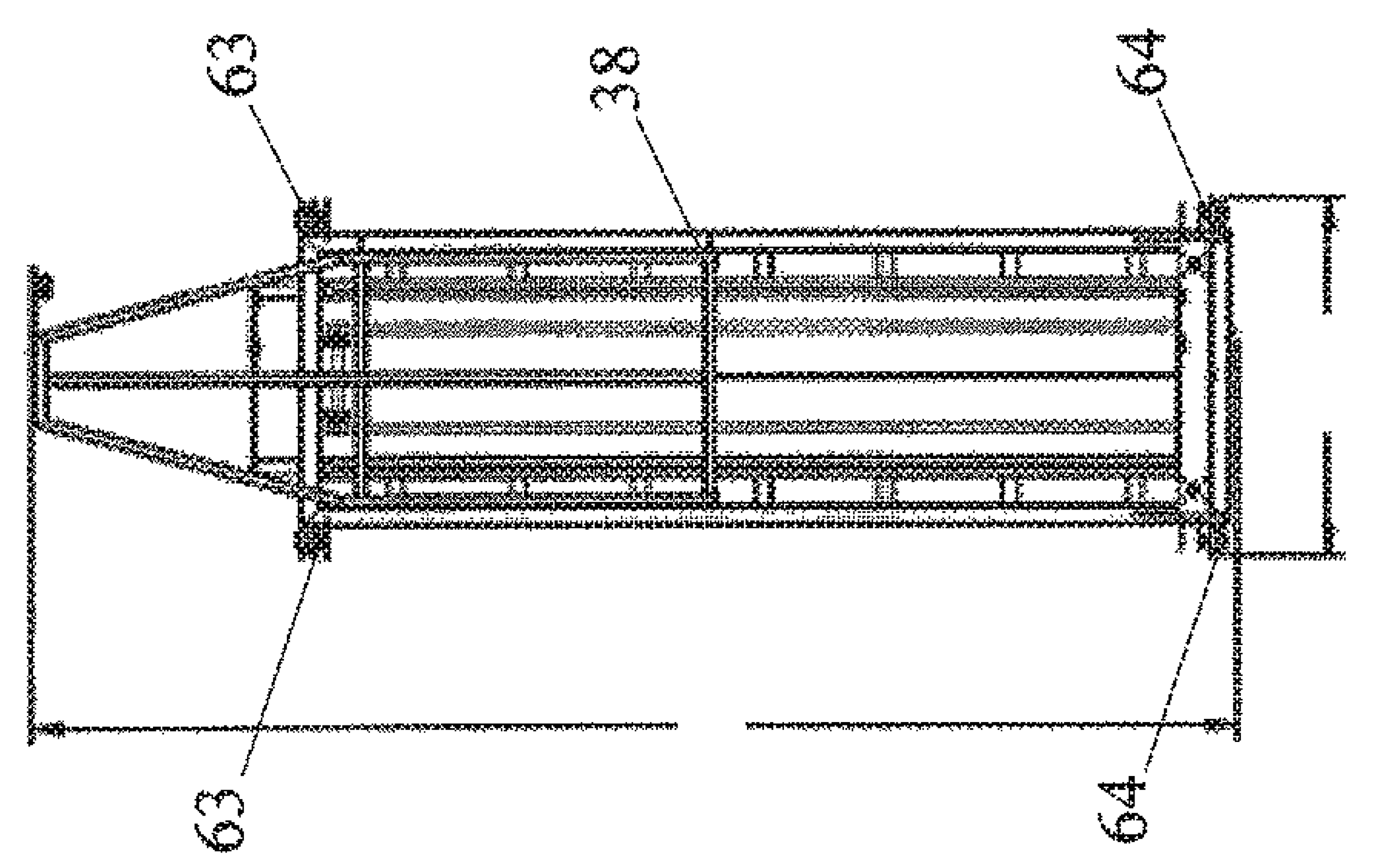


FIG. 6B

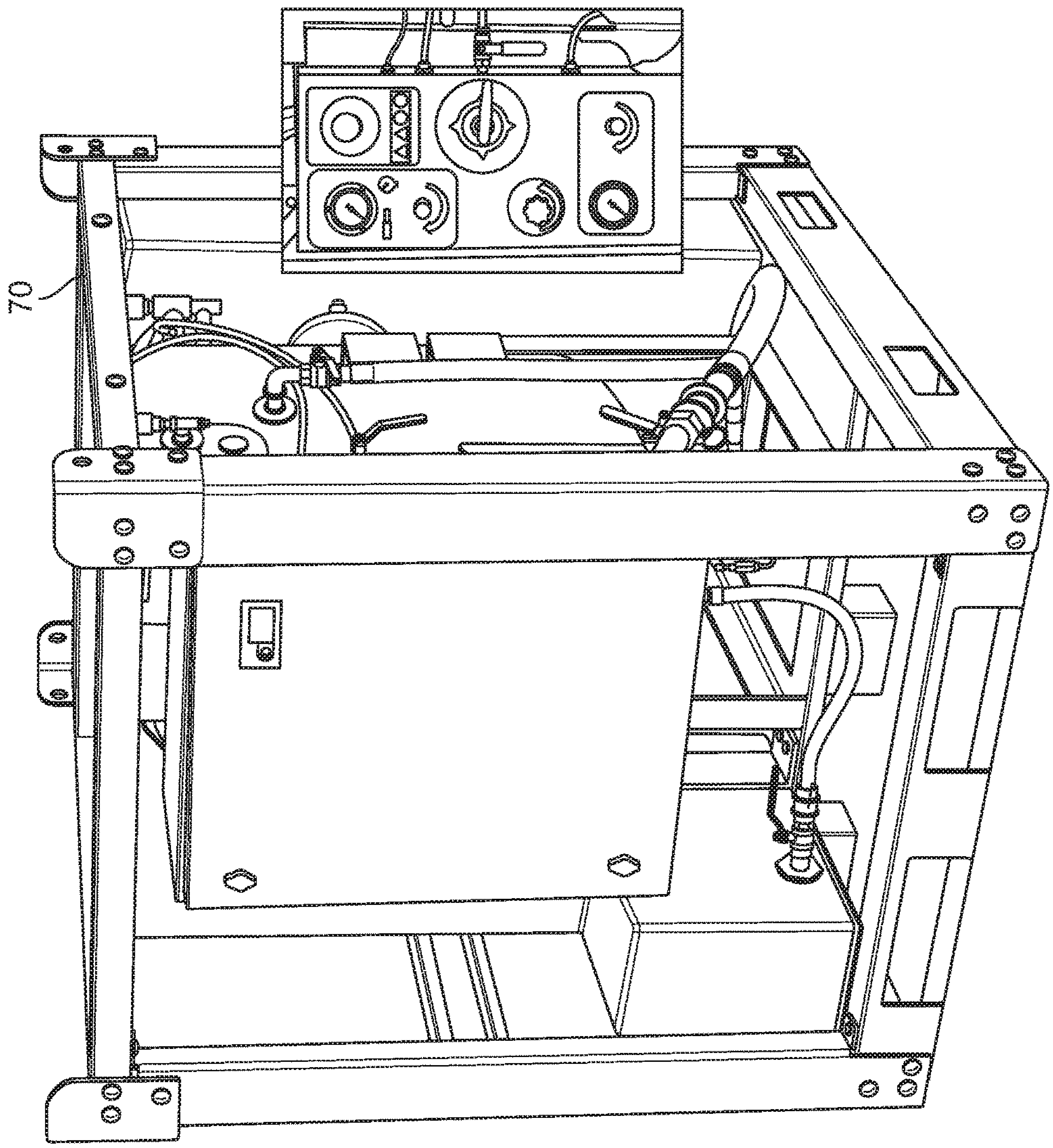


FIG. 7

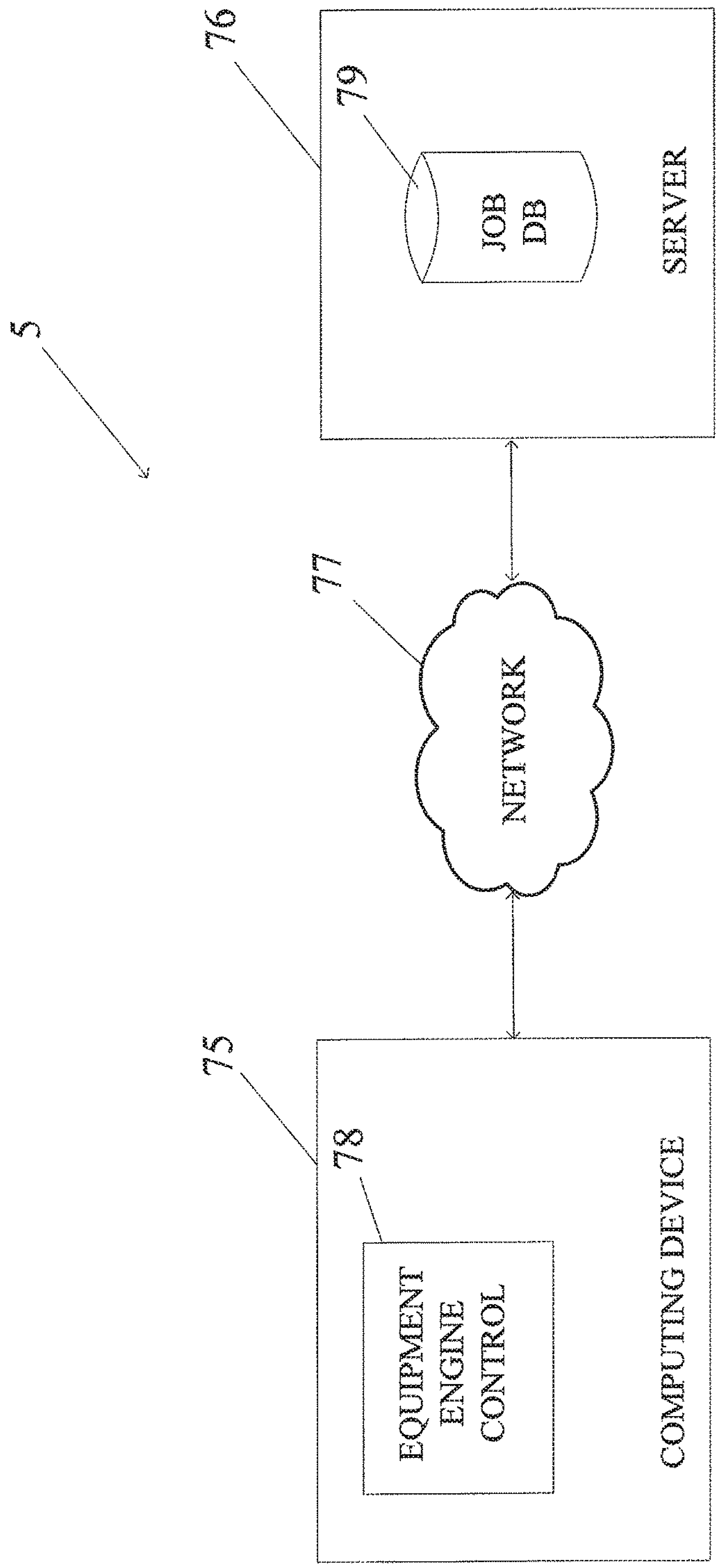

76
79
JOB
DB
SERVER
5
77
NETWORK
75
78
EQUIPMENT
ENGINE
CONTROL
COMPUTING DEVICE

FIG. 8

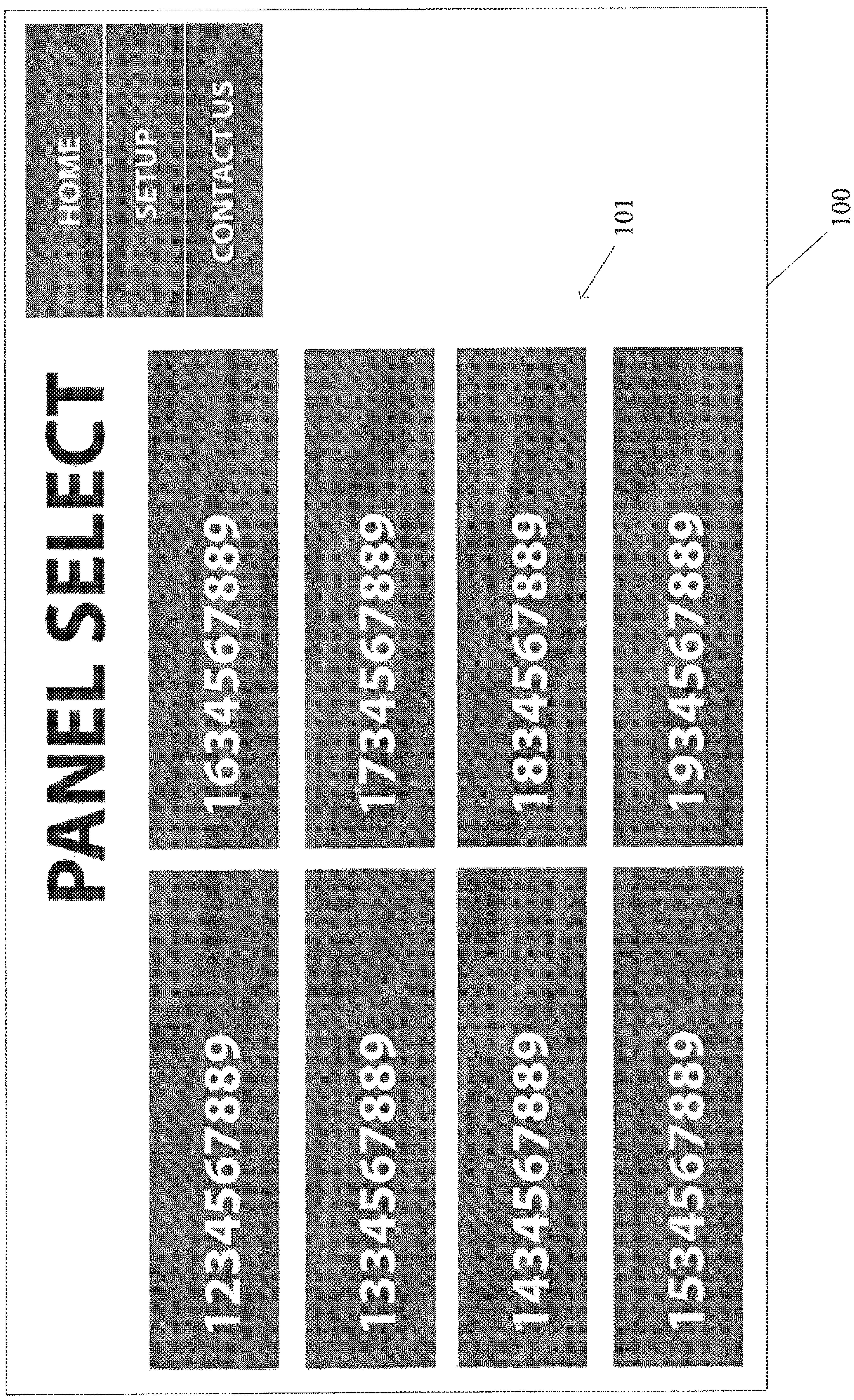

PANEL SELECT
HOME
SETUP
CONTACT US
1234567889
1334567889
1434567889
1534567889
1634567889
1734567889
1834567889
1934567889
101
100

FIG.9

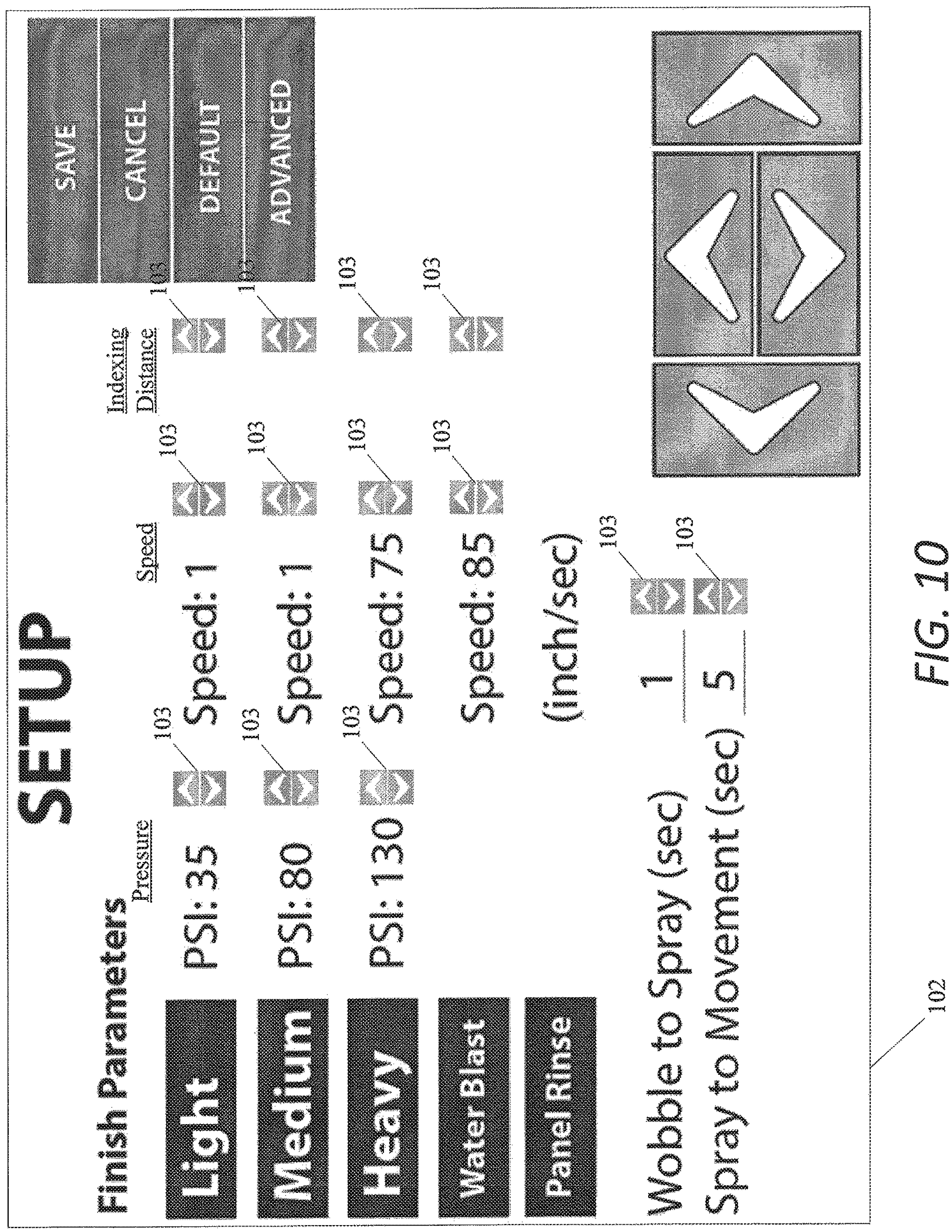
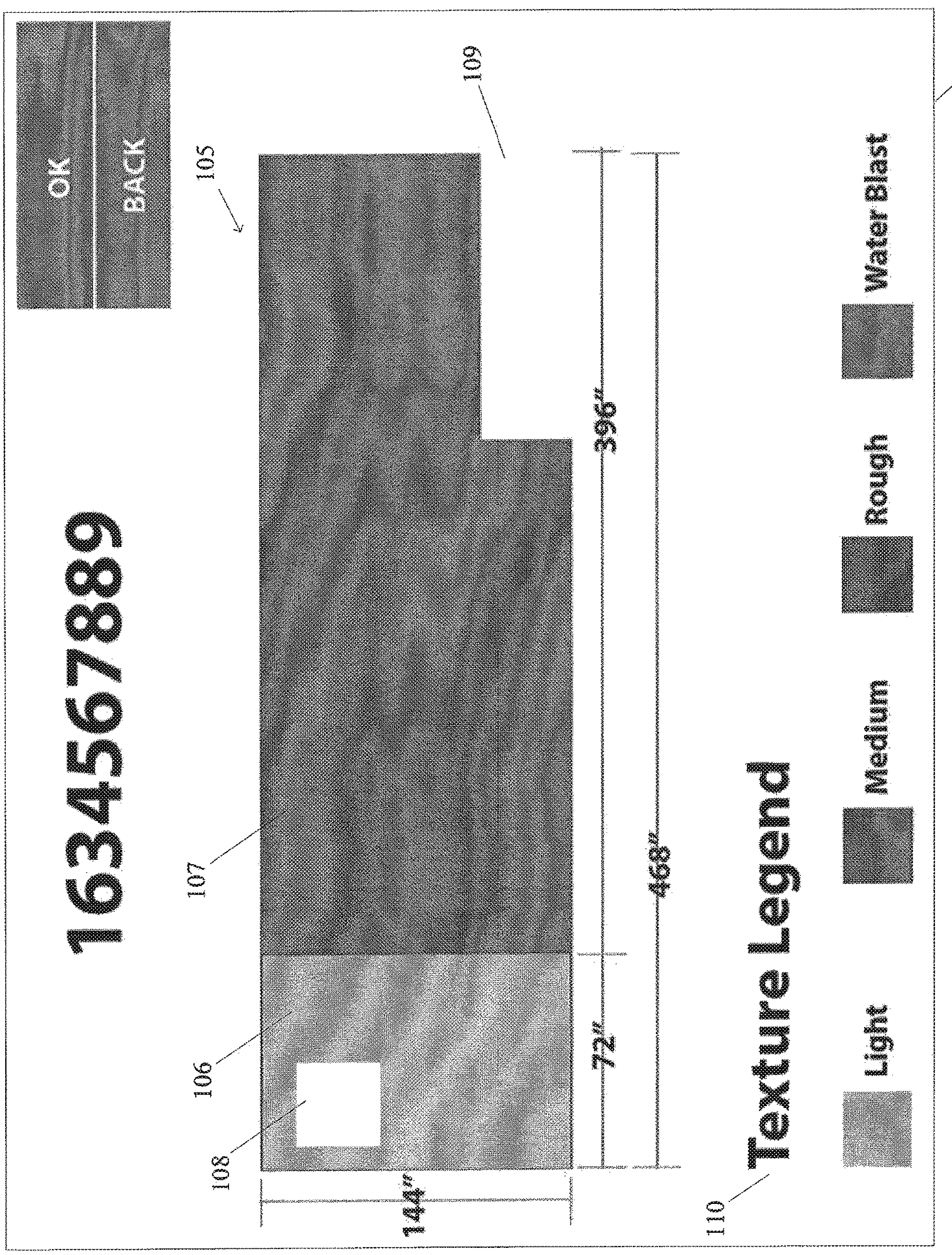
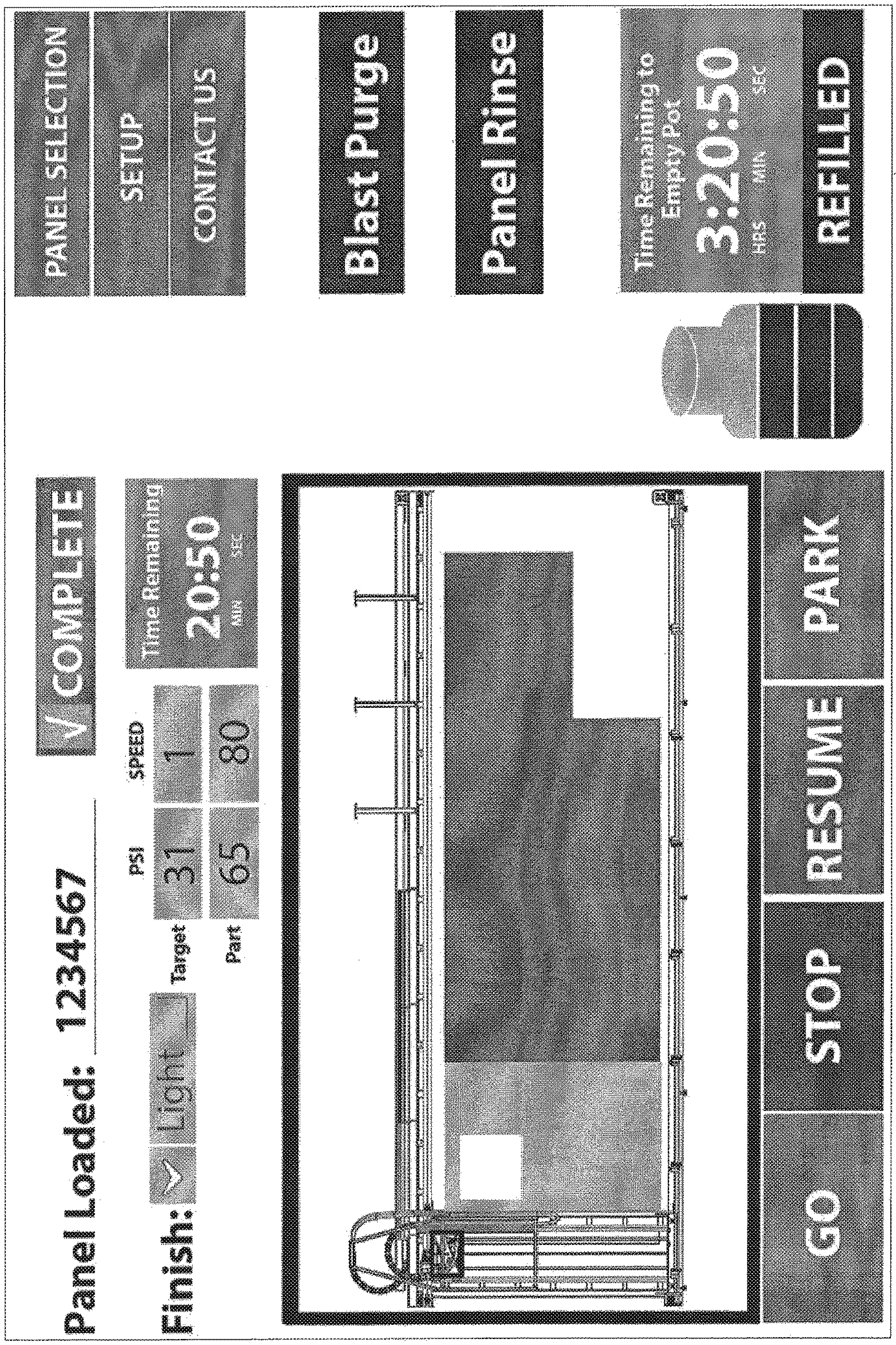

SETUP
Finish Parameters
Pressure
Speed
Indexing Distance
Light
PSI: 35
Speed: 1
Medium
PSI: 80
Speed: 1
Heavy
PSI: 130
Speed: 75
Water Blast
Speed: 85
Panel Rinse
(inch/sec)
Wobble to Spray (sec) 1
Spray to Movement (sec) 5
SAVE
CANCEL
DEFAULT
ADVANCED
103
102

FIG. 10



16345567889
OK
BACK
105
109
104
107
106
108
144"
72"
396"
468"
110
Texture Legend
Light
Medium
Rough
Water Blast

FIG. 11



Panel Loaded: 1234567
Finish:
Light
Target
Part
PSI
SPEED
31
1
65
80
COMPLETE
Time Remaining
20:50
MIN
SEC
PANEL SELECTION
SETUP
CONTACT US
Blast Purge
Panel Rinse
Time Remaining to Empty Pot
3:20:50
HRS
MIN
SEC
REFILLED
GO
STOP
RESUME
PARK

111

FIG. 12

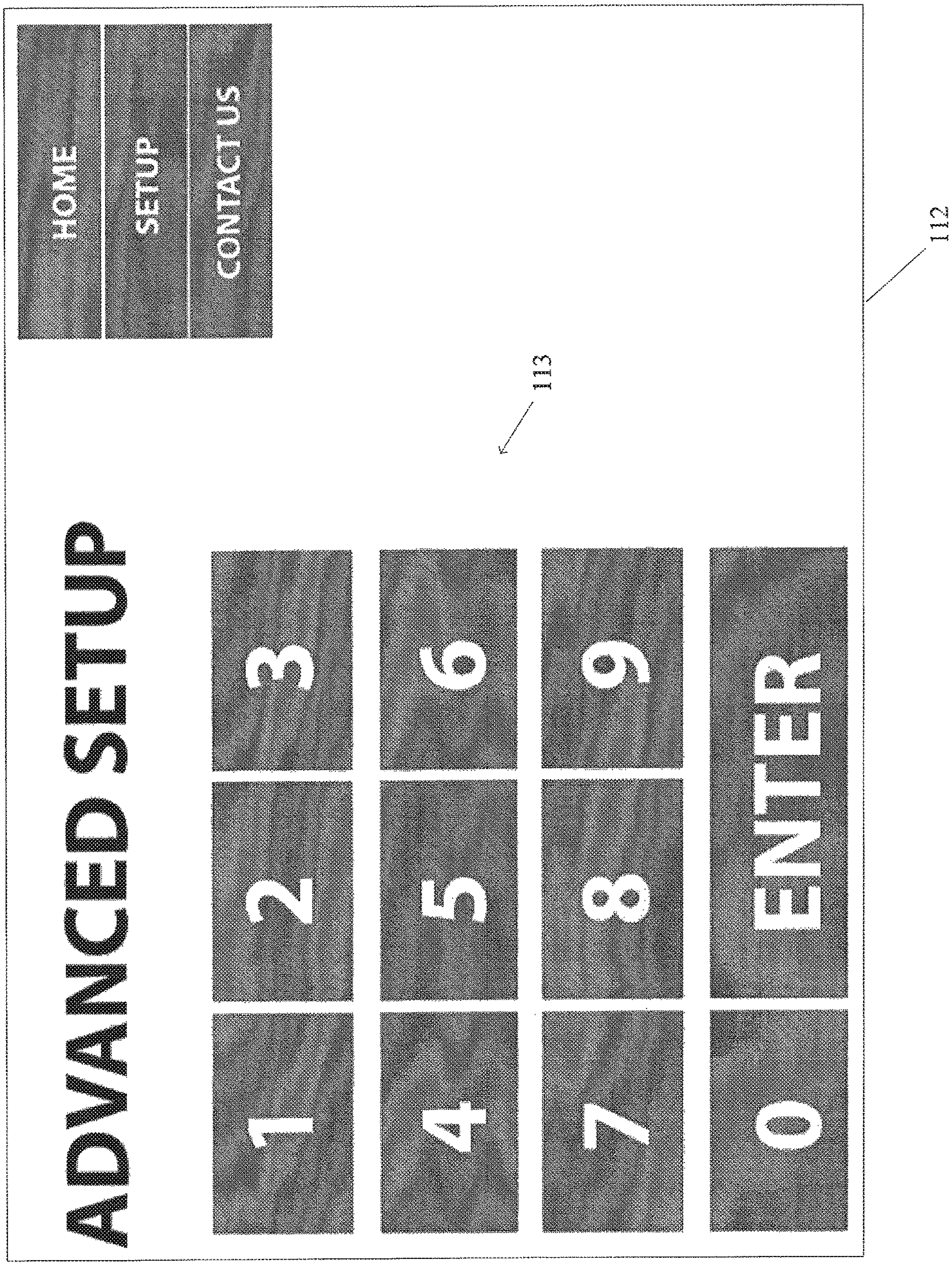
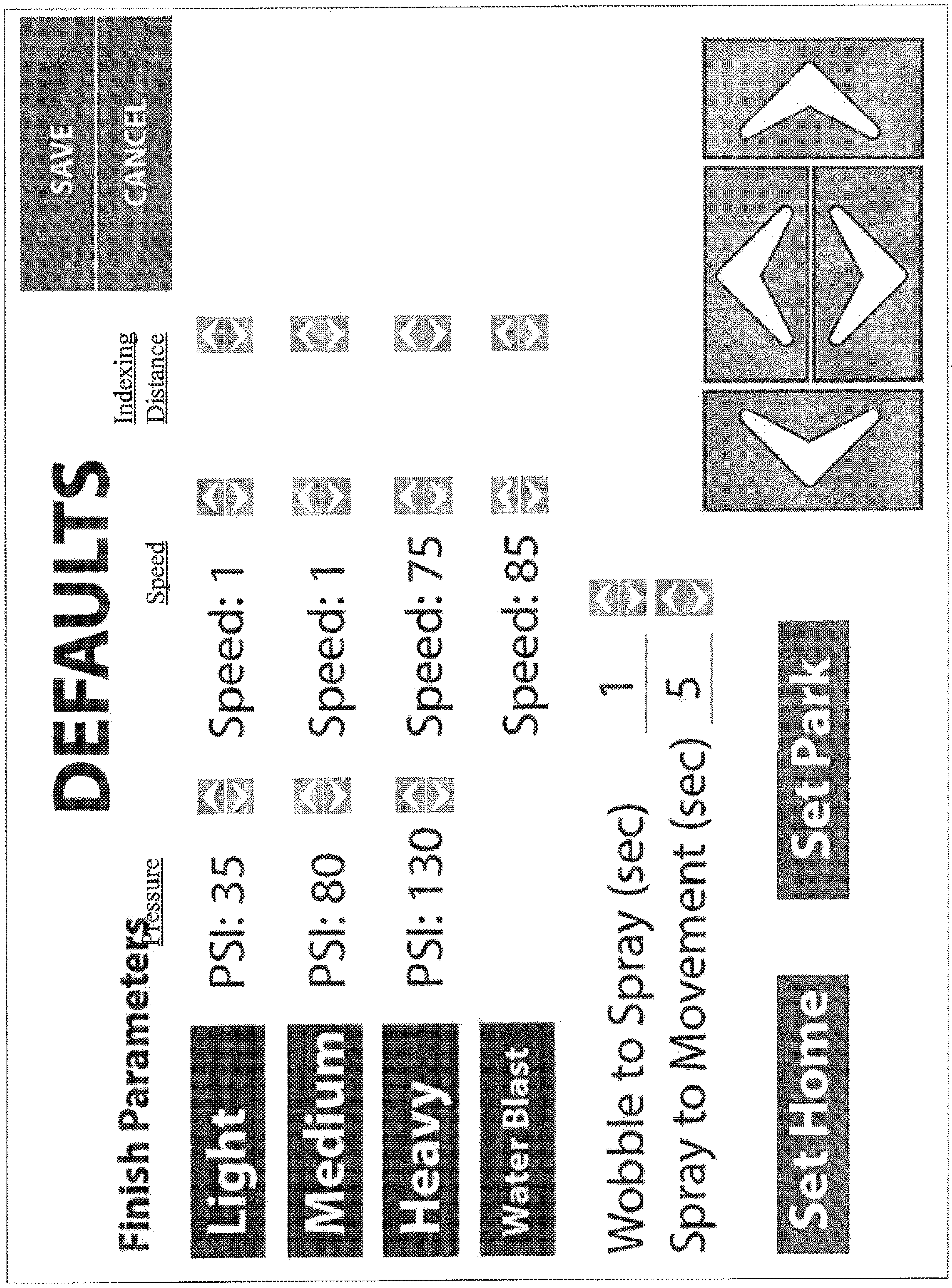

HOME
SETUP
CONTACT US
112
113
ADVANCED SETUP
1
2
3
4
5
6
7
8
9
0
ENTER

FIG. 13


DEFAULTS
Finish Parameters
Pressure
Speed
Indexing Distance
SAVE
CANCEL
Light
PSI: 35
Speed: 1
Medium
PSI: 80
Speed: 1
Heavy
PSI: 130
Speed: 75
Water Blast
Speed: 85
Wobble to Spray (sec) 1
Spray to Movement (sec) 5
Set Home
Set Park

114

FIG. 14

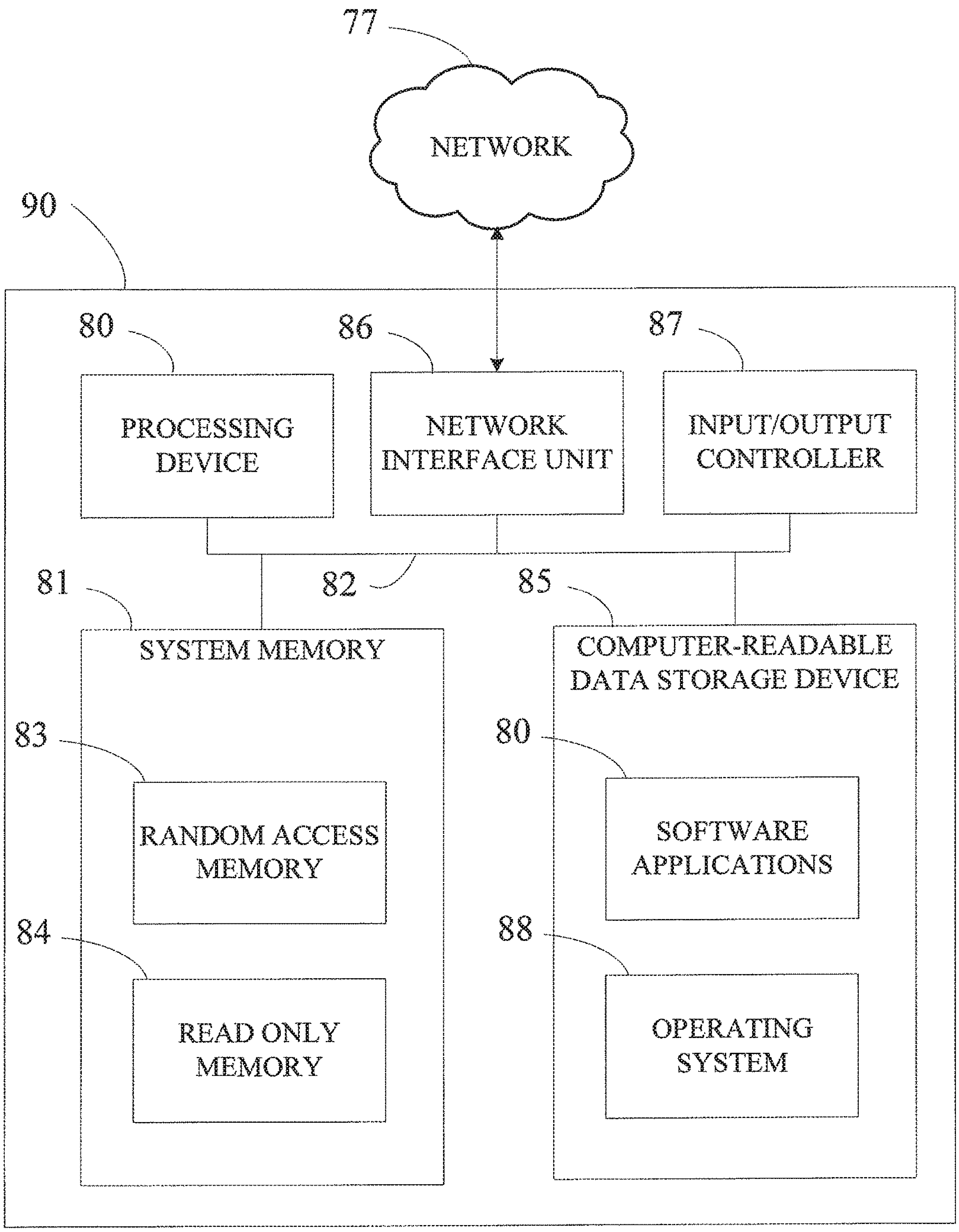

77
NETWORK
90
80
86
87
PROCESSING DEVICE
NETWORK INTERFACE UNIT
INPUT/OUTPUT CONTROLLER
81
82
85
SYSTEM MEMORY
COMPUTER-READABLE DATA STORAGE DEVICE
83
80
RANDOM ACCESS MEMORY
SOFTWARE APPLICATIONS
84
88
READ ONLY MEMORY
OPERATING SYSTEM

FIG. 15

APPARATUS, COMPONENTS, METHODS AND SYSTEMS FOR USE IN SELECTIVELY TEXTURING CONCRETE SURFACES

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application includes the disclosure of, with edits and additions, U.S. provisional 62/371,096, filed Aug. 4, 2016. A claim of priority is made to U.S. provisional 62/371,096 to the extent appropriate. In addition, U.S. provisional 62/371,096 is incorporated herein, by reference, in its entirety.

FIELD OF THE DISCLOSURE

The present disclosure relates to providing a surface portion of an architectural precast concrete wall panel with an abraded texture. Example methods of providing the abraded texture include a step of spraying a surface portion of an architectural precast concrete wall panel with an aqueous-based particulate abrasive mixture. The equipment described includes an aqueous-based particulate abrasive mixture dispenser and a material communication assembly in abrasive flow communication with the aqueous-based particulate abrasive mixture dispenser.

BACKGROUND

Architectural precast concrete wall panels are used in construction of buildings and other structures. The term "architectural precast concrete wall panels" and variants thereof as used herein refers to concrete panels that are used in forming walls that have a perimeter area of at least twenty square feet. The term "perimeter area" and variants thereof as used herein refers to the area circumscribed by an outer perimeter of the surface panel. Thus, the perimeter area is determined without consideration of any apertures through the surface.

Architectural precast concrete wall panels are typically fabricated in a factory or another location that is remote from a construction (building) site where the wall panels will be used. The wall panels are then transported to the construction site (e.g., on a truck bed). At the construction (building) site, the wall panels are erected and secured to one another to form walls of a building.

Precast concrete wall panels are formed by pouring concrete slurry into a mold that has the desired shape of the wall panel. Concrete slurry is a mixture of cement paste and aggregate material. The cement paste is usually formed from water and Portland cement powder. The aggregate material comprises granular material such as sand, gravel, or crushed stone. In the concrete slurry, the cement paste coats the granules of the aggregates and fills voids between the granules. Once mixed, the concrete slurry begins to harden.

Although alternatives are possible, the wall panels have a generally rectangular shape with a width of at least 4 feet (or 1 meter), often in the range of 4-15 fifteen feet (or 1-5 meters) inclusive, and a length of at least 10 feet (or 3 meters), often in the range of 10-50 feet (or 3-16 meters) inclusive. The wall panels are not limited to rectangular shapes though and can include various cutouts for aesthetic/design purposes (e.g., arches or points for a roof line) or for functional purpose (e.g., openings for doors, windows, etc.). Typically, the wall panels have a thickness of at least 3 inches (or 7 centimeters), often in a range of 3-9 inches (or 7-23 centimeters) inclusive, and sometimes even thicker.

Various materials can be added to the concrete. For example, steel rods, cables, or meshes can be added to reinforce the concrete. Insulating materials can also be added. In some cases, the wall panel is formed from multiple layers of concrete separated by a layer of foam insulation. The concrete panel can comprise prestressed concrete if desired.

The wall panels can be formed to have various surface textures, which may be desired for aesthetic or functional purposes. Textures can be produced by spraying an acid wash on the wall panel. The acid wash will abrade the surface of the wall panel, leaving behind a texture. Unfortunately, managing the chemicals used in the acid wash can be time consuming and expensive. Textures can also be produced using dry sand blasting equipment. However, typical dry sand blasting approaches can fill the air with dry particulate matter, which then be managed.

The present application relates to methods, techniques, and equipment for providing a surface portion of an architectural precast concrete wall panel with an abraded texture that overcome the shortcomings of such past approaches as using an acid wash or sand blasting for the abrading.

SUMMARY

In accord with the present disclosure, in general the methods, techniques, and systems characterized herein relate to selectively texturing surfaces, such as surfaces of architectural precast concrete wall panels using spray material dispensing equipment. The spray material will typically be an aqueous-based particulate abrasive mixture. In many applications, the spray material dispensing system includes a spray nozzle assembly that is automatically moved or aimed at different portions of a surface.

It is noted that in some instances, it is desired to provide a pressure washer arrangement in equipment used with precast concrete pieces, in which a pressure washer is used (through direction of spray nozzles) to clean the surface of the precast concrete from blast debris, to remove wax film or to blast uncured concrete from a retarder process. Various systems provided herein can be adapted to include such pressure washer and nozzle arrangements therewith, and to apply such techniques to the concrete slabs whether or not the surfaces are also being abraded.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic depiction of a fabrication site for selectively texturing a concrete surface.

FIG. **2** is a schematic top view of a fabrication site in accord with FIG. **1** that includes a trolley arrangement.

FIG. **3**A is a schematic orthographic view of an example dispenser positioning arrangement usable in accord with certain systems and techniques according to the present disclosure.

FIG. **3**B is a schematic front view of an example dispenser positioning arrangement in accord with FIG. **3**A.

FIG. **3**C is a schematic back view of an example dispenser positioning arrangement in accord with FIG. **3**A.

FIG. **3**D is a schematic top view of an example dispenser positioning arrangement in accord with FIG. **3**A.

FIG. **3**E is a schematic left-side view of an example dispenser positioning arrangement in accord with FIG. **3**A.

FIG. **3**F is a schematic right-side view of an example dispenser positioning arrangement in accord with FIG. **3**A.

FIG. 3G is a schematic top view of an example mounting assembly of the dispenser positioning arrangement in accord with FIG. 3A.

FIG. 4A is a schematic orthographic view of an example spray material dispenser assembly usable in accord with certain systems and techniques according to the present disclosure.

FIG. 4B is a schematic close-up orthographic view of a spray nozzle of an example spray material dispenser assembly in accord with FIG. 4A.

FIG. 4C is a schematic side view of an example spray material dispenser assembly in accord with FIG. 4A.

FIG. 4D is a schematic top view of an example spray material dispenser assembly in accord with FIG. 4A.

FIG. 4E is a schematic close-up top view of an extension assembly of an example spray material dispenser assembly in accord with FIG. 4A.

FIG. 4F is a schematic front view of an example spray material dispenser assembly in accord with FIG. 4A.

FIG. 5A is a schematic top view of the spray nozzle actuator assembly **55** of an aqueous-based particulate abrasive dispenser in accord with FIG. 4A.

FIG. 5B is a schematic orthographic front view of the spray nozzle actuator assembly **55** of the aqueous-based particulate abrasive dispenser in accord with FIG. 4A.

FIG. 5C is a schematic orthography back view of the spray nozzle actuator assembly **55** of the aqueous-based particulate abrasive dispenser in accord with FIG. 4A.

FIG. 5D is a schematic back view of the spray nozzle actuator assembly **55** of the aqueous-based particulate abrasive dispenser in accord with FIG. 4A.

FIG. 5E is a schematic side view of the spray nozzle actuator assembly **55** of the aqueous-based particulate abrasive dispenser in accord with FIG. 4A.

FIG. 6A is a schematic orthographic view of an example vertical guide rail assembly usable in accord with certain systems and techniques according to the present disclosure.

FIG. 6B is a schematic back view of an example vertical guide rail assembly in accord with FIG. 6A.

FIG. 6C is a schematic top view of an example vertical guide rail assembly in accord with FIG. 6A.

FIG. 6D is a schematic side view of an example vertical guide rail assembly in accord with FIG. 6A.

FIG. 7 is a schematic illustration of an example spray material dispensing equipment usable in accord with certain systems and techniques according to the present disclosure.

FIG. 8 is a schematic illustration of an example control equipment usable in accord with certain systems and techniques according to the present disclosure.

FIG. 9 is a schematic illustration of a job identifier selection screen generated by examples of the control equipment.

FIG. 10 is a schematic illustration of a setup screen generated by examples of the control equipment.

FIG. 11 is a schematic illustration of a job display screen generated by examples of the control equipment.

FIG. 12 is a schematic illustration of another job display screen generated by examples of the control equipment.

FIG. 13 is a schematic illustration of an advanced setup access screen generated by examples of the control equipment.

FIG. 14 is a schematic illustration of an advanced settings screen generated by examples of the control equipment.

FIG. 15 is a schematic view of a computing device usable with certain control equipment according to the present disclosure.

DETAILED DESCRIPTION

I. General Principles

In general, the techniques described herein can be applied to equipment for producing textures on surfaces of products at a factory or another type of worksite. For example, the techniques can be applied to produce a texture on a region of a surface of an architectural precast concrete wall panel with a vapor abrasive blasting material.

Example Methods and Materials for Selectively Texturing Concrete Surfaces

In an example, concrete is selectively textured by spraying a surface portion of the concrete, such as an architectural precast concrete wall panel, with an aqueous-based particulate abrasive mixture under conditions adequate to at least partially abrade the surface portion. Depending on the application, the spraying is sometimes referred to as vapor abrasive blasting. As used herein, the term “vapor abrasive blasting” and variants thereof means spraying an aqueous-based particulate abrasive mixture. The vapor abrasive blasting techniques provided herein produce less dust than traditional dry blasting.

The aqueous-based particulate abrasive mixture includes a mixture of a particulate abrasive material (blasting media) and a liquid (e.g., water with or without additives). Typically, the liquid and particulate abrasive material has a ratio, by volume, of at least 25 parts of particulate abrasive to 1 part liquid and not more than 100 parts of particulate abrasive to 1 part liquid. Although alternatives are possible, the liquid and particulate abrasive material has a ratio, by volume, in the range of 40 to 60, inclusive, parts of particulate abrasive to 1 part liquid.

The liquid is water with or without additives. Typically, the liquid is not acidic and does not include any acidic additives. Typically, the pH of the liquid is at least 6. Although alternatives are possible, the pH of the liquid is typically no greater than 8. Often, the pH of the liquid is at least 6.5 and no greater than 7.5 although alternatives are possible.

The particulate abrasive is typically composed of abrasive particulate materials such as sand, garnet, crushed glass, or mixtures thereof. The abrasive particulate can be characterized in part by Mohs hardness values. Although alternatives are possible, the garnet typically has a Mohs hardness value of at least 7 and often no more than 8. The crushed glass often has a Mohs hardness value selected from the range of 5.5 to 6.5, inclusive, although alternatives are possible.

The particulate abrasive material can be characterized by bulk density. Bulk density is calculated by dividing the dry weight of the particulate abrasive material by its volume. When spraying a particulate abrasive consisting of crushed glass, the crushed glass often has a bulk density that is at least 75 lbs./cubic foot (or 1200 kg/cubic meter), although alternatives are possible. Often the crushed glass has a bulk density that is no greater than 85 lbs./cubic foot (or 1370 kg/cubic meter). When spraying a particulate abrasive consisting of garnet, the garnet typically has bulk density that is at least 75 lbs./cubic foot (or 1200 kg/cubic meter). Although alternatives are possible, the garnet often has a bulk density no greater than of about 80 lbs./cubic foot (or 1370 kg/cubic meter).

The particulate abrasive material can also include particulate matter of various sizes and shapes. Typically, it will be preferred that the particulate matter not be too round. The shapes of the particulate abrasive material can be characterized by the roundness of the particulate. Roundness is a measure of the sharpness of the particulate's corners and edges. Roundness can be calculated as a ratio of the average radius of the edges or corners of a particulate abrasive to the radius of the maximum inscribed sphere. Spraying the aqueous-based particulate abrasive mixture can include spraying a mixture in which at least 95% by weight of the particulate abrasive material has an angular (roundness: no greater than 0.15) or sub-angular (roundness: 0.15-0.25) shape.

The size of the particulate abrasive material can be characterized by the size of mesh through which the particulate would pass. Spraying the aqueous-based particulate abrasive material can include spraying a mixture in which at least 95% by weight of the particulate abrasive material is sized to pass through a mesh size of at least 4 openings per linear inch (or 1 opening per linear centimeter) or 10 openings per linear inch (or 3 openings per linear centimeter) and of no greater than 20 openings per linear inch (or 8 openings per linear centimeter) or 100 openings per linear inch (or 40 openings per linear centimeter).

The pressure at which the aqueous-based particulate abrasive mixture is sprayed is selected based on the desired surface texture. Equipment that is adapted for spaying the aqueous-based particulate abrasive mixture, such as an ECOQUIP EQ600s vapor abrasive blast equipment from Graco, Inc. of Minneapolis, Minn. 55413, is typically capable of spraying material at pressures between 30-140 pounds per square inch (psi) (or 200-1000 kPa) inclusive, although alternatives are possible.

Typically, a wall panel will have two non-edge sides. The non-edge sides are defined by the perimeter (outer) edges of the wall panel. As used herein, the term "surface portion" and variants thereof refers to at least some of the surface of a non-edge side of a wall panel. A surface portion can refer to the entire surface of a non-edge side of a wall panel or a lesser portion of the non-edge side.

The techniques described herein can be used to apply a surface texture to a selected portion of a surface portion. As used herein, the term "selected portion" and variants thereof refers to a contiguous portion of a surface portion of a wall panel. Although alternatives are possible, the selected portion is typically at least 4 square feet (or 0.3 square meters), although it is often at least 8 square feet (or 0.6 square meters), or even at least 16 square feet (or 1.2 square meters).

The selected portion of the wall panel can be prepared with a light texture (exposure), a medium texture (exposure), or a heavy texture (exposure). The term "light texture" and variants thereof as used herein means a texture generated by abrading the surface portion such that no greater than 25% of the abraded surface portion is abraded to expose aggregate embedded in the architectural precast concrete wall panel. For example, a wall panel with a light texture has a surface film of cement paste removed from the concrete, exposing edges of course aggregate embedded in the concrete. Typically, when abrading to a light texture, the spraying is at a pressure of no greater than about 35 psi (or 250 kPa).

The term "medium texture" and variants thereof as used herein means a texture generated by abrading the surface portion such that more than 25% and less than 75% of the abraded surface portion is sufficiently abraded to expose aggregate embedded in the architectural precast concrete wall panel. Although alternatives are possible, the abraded surface portion is typically at least 4 square feet (or 0.3 square meters). A wall panel with a medium texture has more cement paste removed from the surface than the light texture, exposing approximately equal amounts of aggregate and cement paste. Typically, when abrading to a medium texture, the spraying is at a pressure of no greater than about 80 psi (or 550 kPa).

The term "heavy texture" and variants thereof as used herein means a texture generated by abrading the surface portion such that at least 75% of the abraded surface portion is sufficiently abraded to expose aggregate embedded in the architectural precast concrete wall pane. Although alternatives are possible, the abraded surface portion is typically at least 4 square feet (or 0.3 square meters). A wall panel with a heavy texture has most of the cement paste on the surface removed, leaving primarily aggregate exposed. Typically, when abrading to a heavy texture, the spraying is at a pressure of no greater than about 130 psi (or 900 kPa).

Of course, the number of types of textures and specific regions of textures that can be obtained with techniques according to the present disclosure is subject to infinite variation, depending on the choice of the user. The above are meant to indicate variations that can be viewed as different classes or sets of techniques.

It is noted that in general, a finish texture is not necessarily simply a matter of the variables identified previously, although those are the ones in which focus is placed in accord with the present disclosure. Finish texture will typically be controlled/managed by nozzle speed, distance of separation of the nozzle from the work surface, wobble of the nozzle during use, and other described variations.

It is also noted that exposed aggregate finish can be accomplished by using retarder during the concrete production process and using a power wash function to water blast the retarder, in a system in accord with the present disclosure.

Examples of Sprayer System and Associated Techniques

Examples of the sprayer system for abrading a concrete surface include various types of spray dispensing equipment that can spray an aqueous-based particulate abrasive mixture under conditions adequate to at least partially abrade a surface portion of concrete. In an example, the sprayer system is configured to sufficiently mix a small amount of liquid with an abrasive particulate material so that the liquid encapsulates the abrasive particulate. The sprayer system is then used to spray a spray material against a concrete surface, such as a selected portion of a surface portion of an architectural precast concrete wall panel. When the surface is struck by a sufficient amount of spray material under sufficient conditions, a portion of the surface (e.g., cement paste) is abraded, exposing an interior of the product, such as aggregate embedded in the concrete. Various properties of the sprayer system can be adjusted to alter the texture generated on the surface of the concrete. For example, spraying using a higher pressure setting will generate a heavier (rougher) texture on the surface, while using a lower pressure setting will generate a lighter (smoother) texture on the surface. Other parameters of the sprayer system can also be varied to alter the texture that is produced on the surface (e.g., different types of material can be dispensed). Typically, the textures are applied for aesthetic purposes, to allow another coating or surface treatment to be applied thereon, or for other reasons.

The examples described herein often relate to the production of a texture on a surface portion of an architectural precast concrete wall panel. However, it should be understood that the techniques described can also be applied to various other products and in various other settings. One of the last steps in fabricating a concrete panel is to produce a texture on the surface of the concrete panel. Generally, the concrete panel is placed in a spray chamber (room) where the panel is sprayed to produce a desired texture on the surface of the panel. The panel can be brought into the spray chamber with a trolley, crane, hoist, or other machinery for lifting and positioning the panel.

Examples of Material Communication Assembly

The sprayer system includes a material communication assembly that mixes an abrasive particulate media with liquid and delivers a pressurized mixture of wet abrasive particulate media to one or more spray nozzle arrangements in a dispenser. The material communication assembly is connected to the dispenser so as to allow abrasive flow communication to the dispenser. Allowing abrasive flow communication with the dispenser means that that material communication assembly is capable of allowing the aqueous-based particulate abrasive mixture to flow to the dispenser. It should be understood, however, that allowing abrasive flow communication does not require abrasive flow communication but merely requires that the material communication assembly be capable of allowing abrasive flow communication.

The material communication assembly can be adapted from equipment, which is sometimes characterized as a blast pot depending on the nature of the material being delivered and is manufactured by a variety of companies, including for example, Graco, Inc. of Minneapolis, Minn. 55413. The material communication assembly can be a single piece of equipment or multiple pieces of equipment. For example, multiple material communication assemblies can be used to independently deliver material to each spray nozzle arrangement when the connected dispenser includes multiple spray nozzle arrangement.

The material communication assembly is connected to one or more containers (hoppers) that are for holding the abrasive particulate media and a liquid tank for holding a liquid to mix with the abrasive particulate media. The material communication assembly is also connected to an air compressor or another source of pressurized air. In operation, the communication assembly mixes the abrasive particulate media and the liquid at a desired ratio to form an aqueous-based particulate abrasive mixture and then delivers the mixture to the dispenser via a conduit (material communication line) such as a flexible hose.

It is noted that the equipment can be configured so that a distance of the nozzles from one another and/or from the workpiece can be adjusted through automatic programming, for different panel thickness by using proximity sensors and other equipment. The systems can be configured to adjust while applying finish to account for panel alignment variations.

Examples and Techniques Related to the Aqueous-Based Particulate Abrasive Mixture Dispenser

The sprayer system includes a spray nozzle arrangement that can spray material at a concrete surface. Although alternatives are possible, in the examples described herein, the spray nozzle arrangement is mounted on an aqueous-based particulate abrasive mixture dispenser. The spray nozzle arrangement can include one or more spray nozzles that are oriented (aimed) in directions that are approximately parallel with each other.

The dispenser can adjust the spray nozzle arrangement to alter the aim of the one or more spray nozzles. Although alternatives are possible, the dispenser can include a spatial attribute adjustment motor assembly. The spatial attribute adjustment motor assembly can alter the spay nozzle arrangement by adjusting one or both of the position and orientation of the spray nozzles relative to the dispenser.

For example, the motor assembly can cause the spray nozzles to oscillate or wobble. The oscillation causes the spray nozzles to spray, during an oscillation, the aqueous-based particulate abrasive against a contact region of the concrete surface that is larger than would be contacted if the spray nozzles were stationary relative to the dispenser assembly. Preferably, the oscillation is in a two-dimensional pattern that is not linear. Typically, the oscillation is in a round pattern that is ovoid or approximately circular motion. A circular oscillation causes the material emitted by the one or more spray nozzles to abrade approximately circular-shaped regions on the concrete surface.

In embodiments that include multiple spray nozzles, the position of the spray nozzles on the dispenser are typically offset from each other such that the contact regions of material emitted by the nozzles approximately abut (or slightly overlap) each other. In this manner, the rate at which the dispenser assembly can spray the surface portion of the concrete is increased.

The dispenser assembly can include a depth adjustment system that moves the spray nozzle arrangement toward or away from the target concrete surface. In other words, the depth adjustment system moves the spray nozzle arrangement in a direction that is approximately parallel to the direction of spray or tangent to the surface of the target. The depth adjustment system can include a linear actuator, such as a pneumatic arm, that pushes/pulls the spray nozzle arrangement toward or away from the target concrete surface. Alternatively, the dispenser assembly is mounted on a rail that is oriented in the direction of the intended target location on linear motion bearings that allow movement along the rail toward or away from the target. In this manner, the dispenser assembly can adapt to spray surface portions of architectural precast concrete wall panels of a variety of different thicknesses by repositioning the nozzles so that spraying is performed from the same distance from the target regardless of the thickness of the target. For example, architectural precast concrete wall panels often have thicknesses of between 3-9 inches (7-22 centimeters) inclusive or more.

Examples and Techniques Related to Dispenser Positioning Arrangement

A dispenser positioning arrangement can automatically alter the position of the aqueous-based particulate abrasive mixture dispenser relative to a concrete surface. The dispenser positioning arrangement uses machine power to direct and move the aqueous-based particulate abrasive mixture dispenser. In an example, the dispenser positioning arrangement can move the dispenser in two dimensions that define a plane that is approximately parallel to the concrete surface. For example, the dispenser positioning arrangement includes a first position adjustment system that adjusts the position of the dispenser along a first axis of the plane. The dispenser positioning arrangement also includes a second position adjustment system that adjusts the position of the dispenser along a second axis of the plane that is approximately perpendicular to the first axis. Although alternatives are possible, in the example disclosed herein, the first axis is a vertical axis and the second axis is a horizontal axis. In this manner, the two position adjustment systems can together position (move) the dispenser in two dimensions across a surface of the panel.

Various techniques can be used in the dispenser positioning equipment. One technique includes a framework having a first guide rail assembly oriented to the axis of the first position adjustment system and a second guide rail assembly oriented to the axis of the second position adjustment system. The dispenser assembly is connected to the first guide rail assembly via a linear motion bearing that allows the dispenser assembly to move linearly along the first axis. So, for example if the first axis is vertical, the dispenser assembly can be moved up and down the first guide rail assembly by a linear actuator (e.g., a servomotor or a motorized pulley or winch system) to adjust the vertical position of the dispenser assembly. The first guide rail assembly is connected to the second guide rail assembly via linear motion bearings that allow the entire first guide rail assembly to be moved along the second guide rail assembly by another linear actuator.

Example Techniques for Controlling the Spray Dispensing Equipment

The sprayer system can include control equipment. The control equipment controls the operation of the spray system, including the aqueous-based particulate abrasive mixture dispenser, the dispenser assembly, and the dispenser positioning arrangement. The control equipment transmits control signals to cause the abrasive mixture dispenser to produce and deliver the aqueous-based particulate abrasive mixture to the dispenser, to cause the dispenser to cause the spray nozzle arrangement to oscillate and spray the mixture, and to cause the dispenser positioning arrangement to move the dispenser across a plane that is approximately perpendicular to a target concrete surface.

Although alternatives are possible, the control equipment can include a computer that transmits control signals to various components of the sprayer system. For example, the control equipment can transmit control signals that activate and control the pressure and delivery of material provided by the material delivery equipment. Additionally, the control equipment can transmit control signals to the dispenser positioning equipment to adjust the position of the dispenser assembly.

The control equipment typically accesses job data about a current job target (e.g., an architectural precast concrete wall panel). The job data can be loaded from a local data store or a data store available over the network. The job data is often associated with a job identifier that is entered by an operator of the sprayer system (e.g., by typing a numeric identifier, selecting an entry in a list displayed on a screen, scanning a barcode, or otherwise). Alternatively, the control equipment can read the job identifier from the target directly (e.g., from a radio frequency identification (RFID) tag, using near field communication, or by scanning a barcode or similar identifier affixed to the target). The job data can define spray parameters such as a spray pressure for the target. The job data can also divide the target into multiple regions that can have different spray parameters. In this manner, the surface on the job target can have different textures that, for example, add an aesthetic strip or pattern to the building that is ultimately constructed with the architectural precast concrete wall panels. Additionally, the job data can also define regions that are not to be sprayed at all (e.g., openings in the panel where windows or doors will be installed at the building site).

In some examples, the job data defines a motion path for the dispenser to follow to produce the desired texture on the target or in the regions of the target. Alternatively, the control equipment determines a motion path for the dispenser based on the dimensions of the target or regions therein.

As an example, the motion path can include a plurality of horizontal line segments that are offset from one another vertically. The line segments may start on one side of a selected region of the target concrete surface and end on the opposite end of the selected region. The control equipment then transmits various control signals to the sprayer system to cause the dispenser positioning equipment to position the dispenser to follow the motion path while the aqueous-based particulate abrasive mixture is sprayed at the surface portion of the job target using the dispenser. For example, the control equipment can send a control signal to cause the dispenser position system to move the dispenser horizontally along the horizontal guide rail from one end of a horizontal line segment to another. After the dispenser reaches the end of the horizontal line segment, the control equipment can send a control signal to cause the dispenser to move to a start point of a second horizontal line segment (e.g., by causing the dispenser to move vertically up or down). The control equipment can then cause the dispenser to move along the second horizontal line segment.

The control equipment can also transmit a speed control signal that controls the speed of the horizontal movement of the dispenser positioning system. Typically, the speed of the movement is selected based on the desired surface texture and the spray pressure. Although alternatives are possible, if a light or medium texture is desired, a speed of no greater than 20 inches/second (or 51 cm/second) is typically selected. Although alternatives are possible, a speed of at least 0.5 inches/second (or 1 cm/second) is often selected.

If a heavy texture is desired, a speed of at least 1 inch/second (or 2.54 cm/second) is typically selected. Often, a speed no more than 20 inches/second (or 50.8 cm/second), inclusive, is selected, although alternatives are possible. Because the heavy texture is typically applied using a higher pressure, the dispenser can and often should move slower across the concrete surface.

B. An Example of the Techniques and a System of Use

A typical system of use and application of techniques according to the present disclosure can be understood from reference to FIGS. **1**-**7**. FIGS. **1**-**7** relate to an example involving a sprayer system being used to generate a texture on a surface of an architectural precast concrete wall panel. The techniques and systems described herein are also applicable to other types of concrete surfaces.

Referring first to FIG. **1**, a schematic depiction of a fabrication site for selectively texturing a concrete surface is provided. Referring to FIG. **1**, at **1**, a sprayer system is generally indicated. A spray chamber is generally indicated at **2**. The spray chamber **2** is a chamber, such as room, in which the architectural precast concrete wall panels are placed for the purpose of generating a texture on a surface thereof. As the architectural precast concrete wall panels are usually quite large, the spray chamber is also typically quite large so as to contain the wall panels. Typically, at least a portion of the sprayer system is located in the spray chamber and is secured to the chamber (e.g., the floor and ceiling of the chamber) in a manner that would make it quite difficult to relocate the sprayer system. Instead, the wall panels are moved into the chamber and positioned so that the sprayer system can spray a surface portion thereof. Various type of equipment, such as trolleys or hoists, can be used to position the wall panels within the spray chamber.

The system **1** can spray a surface portion of an architectural precast concrete wall panel with an aqueous-based particulate abrasive mixture under conditions adequate to at least partially abrade the surface portion. The system **1** would typically include, provided therewith, at least the following: an aqueous-based particulate abrasive dispenser (dispenser assembly) **14**; a material communication assembly **3** that delivers spray material to the aqueous-based particulate abrasive dispenser **14**; a dispenser positioning arrangement **4** that includes machinery to position the aqueous-based particulate abrasive dispenser **14**; and control equipment **5**; and various material containers and material communication assemblies.

The aqueous-based particulate abrasive dispenser **14** receives the aqueous-based particulate abrasive mixture and sprays it into a selected portion of a concrete surface under conditions adequate to abrade the selected surface to a desired texture. The aqueous-based particulate abrasive dispenser **14** includes a spray nozzle arrangement **21** with one or more spray nozzles, such as spray nozzle **15** and spray nozzle **16**. Although alternatives are possible, the spray nozzle **15** and the spray nozzle **16** are offset from each other. As will be described in more detail herein, the aqueous-based particulate abrasive dispenser **14** can also include an actuator assembly for adjusting where the spray nozzle arrangement **21** (or the spray nozzles therein) are aimed and a depth adjustment assembly for moving the spray nozzle arrangement **21** towards or away from a target concrete surface.

The material communication assembly **3** produces an aqueous-based particulate abrasive mixture and delivers the mixture to the aqueous-based particulate abrasive dispenser **14** under sufficient pressure to abrade the target concrete surface. Although alternatives are possible, in the example herein, the material communication assembly **3** includes a pressurized aqueous-based particulate abrasive production assembly **22**; a pressurized gas assembly **9**, a liquid holding assembly **10**, a material holding assembly **23**, and a material communication assembly **13**.

The pressurized aqueous-based particulate abrasive production assembly **22** can mix liquid and particulate abrasive (spray or blasting media) at a desired ratio to produce the aqueous-based particulate abrasive mixture. The pressurized aqueous-based particulate abrasive production assembly **22** can then pressurize the aqueous-based particulate abrasive mixture using air pressure.

The pressurized aqueous-based particulate abrasive production assembly **22** includes one or more spray material mixing and dispensing equipment arrangements **6**, **7**, **8**. The spray material mixing and dispensing equipment arrangements **6**, **7**, **8** (sometimes characterized as blast pots depending on the use) are connected to the pressurized gas assembly **9**, the liquid holding assembly **10**, and the material holding assembly **23**. The spray material mixing and dispensing equipment arrangements **6**, **7**, **8** mix particulate abrasive material (spray or blasting media) from the material holding assembly **23** with liquid from the liquid holding assembly **10** to form a flowable aqueous-based particulate abrasive mixture. The spray material mixing and dispensing equipment arrangements **6**, **7**, **8** then use pressurized air from the pressurized gas assembly **9** to pressurize and deliver the aqueous-based particulate abrasive mixture to the aqueous-based particulate abrasive dispenser **14** via the material communication assembly **13**. An example of the spray material mixing and dispensing equipment arrangements **6**, **7**, **8** can be adapted from EcoQuip EQ600s systems from Graco Inc.

The pressurized gas assembly **9** is equipment that provides pressurized gas. An example of the pressurized gas assembly **9** is air compressor. Another example is a pressurized tank. The pressurized gas assembly **9** can includes combinations of one or more air compressors and one or more pressurized tanks. Although alternatives are possible, the pressurized gas assembly typically provides pressurized air.

The liquid holding assembly **10** is a structure that holds a liquid for mixing with the material. Typically, the liquid is water or another aqueous-based liquid. The liquid holding assembly **10** is typically sized to hold at least 50 gallons (or 190 liters) or sometimes much more. Although alternatives are possible, in the example of FIG. **1**, the liquid holding assembly **10** is a 275 gallon tank. The liquid holding assembly **10** can, however, be sized to hold different quantities of liquid. The liquid holding assembly **10** can also include multiple tanks.

The material holding assembly **23** is a structure that holds particulate abrasive material (media) that is combined with liquid in the pressurized aqueous-based particulate abrasive production assembly **22** to generate the aqueous-based particulate abrasive mixture (spray material). Although alternatives are available, the example material holding assembly **23** in FIG. **1** includes material containers (hoppers) **11**, **12**. The material containers can include an open top for receiving the media and a tapered bottom for directing the media to the pressurized aqueous-based particulate abrasive production assembly **22**.

The material communication assembly **13** is an assembly that connects the pressurized aqueous-based particulate abrasive production assembly **22** to the aqueous-based particulate abrasive dispenser **14**. The material communication assembly **13** can include one or more conduits through which the pressurized spray material flows. For example, the material communication assembly **13** can include flexible hoses.

The dispenser positioning arrangement **4** is a mechanical structure that includes machinery to position the aqueous-based particulate abrasive dispenser **14**. The dispenser positioning arrangement **4** uses machine power and machine direction to move the aqueous-based particulate abrasive dispenser **14** relative to a target concrete surface. The dispenser positioning arrangement **4** includes a framework **24** to which the aqueous-based particulate abrasive dispenser **14** is connected.

Although alternatives are possible, in the example shown in FIG. **1**, the framework **24** includes a vertical guide rail assembly **17** and a horizontal guide rail assembly **18**. The aqueous-based particulate abrasive dispenser **14** is attached to the vertical guide rail assembly **17** with a linear motion bearing assembly that allows the aqueous-based particulate abrasive dispenser **14** to move up and down along the vertical guide rail assembly **17**. The vertical guide rail assembly **17** is attached to the horizontal guide rail assembly **18** with a linear motion bearing assembly that allows the vertical guide rail assembly **17** to move horizontally along the horizontal guide rail assembly **18**. As will be described further herein, the dispenser positioning arrangement **4** also includes one or more position adjustment systems, such as linear actuators, that use machine power to adjust the position of the aqueous-based particulate abrasive dispenser **14** along the vertical guide rail assembly **17** or the aqueous-based particulate abrasive dispenser **14** and vertical guide rail assembly **17** along the horizontal guide rail assembly **18**.

The control equipment **5** controls the operation of the system **1**. For example, the control equipment **5** can send control signals to one or more of the material communication assembly **3**, the dispenser positioning arrangement **4**, and the aqueous-based particulate abrasive dispenser **14**. The control equipment **5** can load job parameters for a target (e.g., a particular architectural precast concrete wall panel) of the system **1** to determine how to control the operation of the system **1**. The job parameters may be loaded from job data that is stored in a local data store, a remote data store available over a network, or elsewhere. The job parameters can include information such as the dimensions of the target and sometimes the dimensions of regions within the target. The job parameters can also include a width of the target that can be used to control the depth adjustment assembly of the aqueous-based particulate abrasive dispenser **14**. The job parameters can also include various spray settings such as a desired spray pressure, mixture settings, spray rate, speed of movement, etc.

In operation, for example, the control equipment **5** sends position control signals to the dispenser positioning arrangement **4** to position the aqueous-based particulate abrasive dispenser **14** at a starting position for the job (e.g., as determined based on the job parameters). Then, the control equipment **5** sends control signals to activate the material communication assembly **3** to begin delivering pressurized spray material to the aqueous-based particulate abrasive dispenser **14**; to activate the aqueous-based particulate abrasive dispenser **14** to begin actuating the spray nozzle **15** and the spray nozzle **16**; and to the dispenser positioning arrangement **4** to begin moving the aqueous-based particulate abrasive dispenser **14** along a movement path determined based on the job parameters. An example movement path may comprise a series of horizontal lines in alternating directions, in which each line is vertically offset from the previous one. The vertical offset between lines is based on the expected contact region of the spray material on the target. In this manner, the control equipment **5** causes the aqueous-based particulate abrasive dispenser **14** to spray an entire surface of the job target or at least a region thereof.

In FIG. **1** at **20**, a pressure wash arrangement included within the equipment is shown. This can be used to generate a pressure spray for various uses during operation of the equipment.

FIG. **2** is a schematic top view of an embodiment of the system **1** that includes a trolley arrangement **25**. The trolley arrangement **25** is a mechanical apparatus that positions the target (architectural precast concrete wall panel) for use with the system **1**. Although alternatives are possible, the trolley arrangement **25** includes a hoist assembly that is connected to a ceiling mounted rail path with linear motion bearings. The hoist assembly can attach to and lift the target (e.g., an architectural concrete wall panel). The hoist assembly can then move along the rail path to position the target appropriately for spraying with the spray equipment. Depending upon the design of the hoist assembly, the linear motion bearings can slide, roll, or otherwise move along the rail path. The hoist assembly can be moved by a motorized system or by an operator. Other techniques for positioning the target are possible as well. For example, the target could be positioned using a fork lift, a ceiling mounted hoist, a motorized cart, etc.

FIGS. **3**A-**3**G are schematic illustrations of the dispenser positioning arrangement **4**. More specifically, FIG. **3**A is a schematic orthographic view of the example of the dispenser positioning arrangement **4**. FIG. **3**B is a schematic front view of the example of the dispenser positioning arrangement **4**. FIG. **3**C is a schematic back view of the example of the dispenser positioning arrangement **4**. FIG. **3**D is a schematic top view of the example of the dispenser positioning arrangement **4**. FIG. **3**E is a schematic left-side view of the example of the dispenser positioning arrangement **4**. FIG. **3**F is a schematic right-side view of the example of the dispenser positioning arrangement **4**. FIG. **3**G is a schematic top view of an example mounting assembly of the dispenser positioning arrangement **4**.

As described previously, the dispenser positioning arrangement **4** includes a vertical guide rail assembly **17** and horizontal guide rail assembly **18**. The vertical guide rail assembly **17** is a physical structure that can be used to support and position the dispenser assembly vertically. For example, the aqueous-based particulate abrasive dispenser **14** can be moved up and down along the vertical guide rail assembly **17**. Although alternatives are possible, the vertical guide rail assembly **17** includes one or more rail assemblies such as the rail assembly **36** and the rail assembly **37**. An enclosure **38** is attached to the aqueous-based particulate abrasive dispenser **14** and is movably coupled to the rail assembly **36** and rail assembly **37**. For example, the aqueous-based particulate abrasive dispenser **14** can be enclosed in the enclosure **38**, which is a rigid cage-like structure. The enclosure **38** can be coupled to the rail assembly **36** and the rail assembly **37** via linear motion bearings. Then as the enclosure **38** moves up and down along the rail assembly **36** and the rail assembly **37**, the aqueous-based particulate abrasive dispenser **14** disposed therein also moves up and down. Alternatively, the dispenser may couple directly to the rail assembly **36** and the rail assembly **37**.

The horizontal guide rail assembly **18** is a physical structure that is can be used to support and position the aqueous-based particulate abrasive dispenser **14** horizontally. For example, the aqueous-based particulate abrasive dispenser **14** can be moved side to side along the horizontal guide rail assembly **18**. Although alternatives are possible, the horizontal guide rail assembly **18** often comprises an upper guide rail assembly **30** and a lower guide rail assembly **31**. In this example, the vertical guide rail assembly **17** is movably attached to both the upper guide rail assembly **30** and the lower guide rail assembly **31**. Alternatively, the vertical guide rail assembly **17** can be coupled to only one of the upper guide rail assembly **30** and lower guide rail assembly **31**. In this manner, the vertical guide rail assembly **17** can move along the span of the horizontal guide rail assembly **18** to position the enclosure **38** and the aqueous-based particulate abrasive dispenser **14** attached thereto for spraying different portions of the target concrete surface.

Although alternatives are possible, the lower guide rail assembly **31** is mounted to the floor and the upper guide rail assembly **30** is mounted to a beam **32** that is mounted to the ceiling of the spray chamber. The upper guide rail assembly **30** can be mounted to the beam **32** with a mounting bracket assembly **33**. Alternatively, the upper guide rail assembly **30** is mounted to the ceiling directly. As another alternative, the upper guide rail assembly **30** is supported by support assembly **53** that is mounted to either the floor or the lower guide rail assembly **31**. The support assembly **53** can comprise one or more rigid posts that are mounted vertically between the upper guide rail assembly **30** and lower guide rail assembly **31**. In some embodiments, the support assembly **53** is used initially to support the upper guide rail assembly **30** during installation and is then removed after the upper guide rail assembly **30** is securely mounted to the beam **32**.

The horizontal guide rail assembly **18** includes a horizontal position adjustment system **34** that moves the vertical guide rail assembly **17** along the upper guide rail assembly **30** and the lower guide rail assembly **31** of the horizontal guide rail assembly **18**. The vertical guide rail assembly **17** includes a vertical position adjustment system **35** that moves the enclosure **38** (including the aqueous-based particulate abrasive dispenser **14**) up and down along the vertical guide rail assembly **17**. Various actuation systems can be used in the horizontal position adjustment system **34** and the vertical position adjustment system **35**, including servomotors, pulley systems, hydraulic or pneumatic telescoping arms, chain drives, and belt-based movement systems.

FIGS. **3**D-**3**F illustrate spray (blast) cone **39** and spray (blast) cone **40** generated by the spray nozzle **15** and spray nozzle **16** respectively. The spray cone **39** and the spray cone **40** illustrate the area where the spray material from the aqueous-based particulate abrasive dispenser **14** is (sprayed) dispensed. The spray cone **39** and the spray cone **40** may move relative to the aqueous-based particulate abrasive dispenser **14** as the spray nozzle **15** and the spray nozzle **16** are actuated within the aqueous-based particulate abrasive dispenser **14**.

Also shown are wash cone **41** and wash cone **42**. Although alternatives are possible, the aqueous-based particulate abrasive dispenser **14** includes a pressure washer nozzle assembly **54** that includes wash nozzle **43** and wash nozzle **44**. The wash nozzle **43** and wash nozzle **44** dispense a wash liquid composed of water and sometimes a cleanser to rinse away material and removed concrete after spraying (blasting) with the spray nozzle **15** and spray nozzle **16**. The pressure washer nozzle assembly **54** can also be used to remove concrete that has not fully set. For example, a portion of the poured concrete (e.g., a surface) can be treated with a retarder that inhibits the concrete from setting. The pressure washer nozzle assembly can be used to spray away the unset concrete, leaving behind a heavy surface texture. Although alternatives are possible, the wash liquid is often sprayed simultaneously with the aqueous-based liquid particulate abrasive mixture.

As indicated previously, water nozzles can also be used for alternate uses, for example to remove wax residue from the concrete surface if such was applied during the process of manufacture.

FIGS. **4**A-**4**F and **5**A-**5**E are schematic illustrations of aspects of an example spray material dispenser assembly **14**. FIG. **4**A is a schematic orthographic view of the spray material dispenser assembly **14**. FIG. **4**B is a schematic close-up orthographic view of the spray nozzle **16** of the aqueous-based particulate abrasive dispenser **14**. FIG. **4**C is a schematic side view of the aqueous-based particulate abrasive dispenser **14**. FIG. **4**D is a schematic top view of the aqueous-based particulate abrasive dispenser **14**. FIG. **4**E is a schematic close-up top view of the extension assembly **45** of the aqueous-based particulate abrasive dispenser **14**. FIG. **4**F is a schematic front view of the aqueous-based particulate abrasive dispenser **14**. FIG. **5**A is a schematic top view of the spray nozzle actuator assembly **55** of the aqueous-based particulate abrasive dispenser **14**. FIG. **5**B is a schematic orthographic front view of the spray nozzle actuator assembly **55** of the aqueous-based particulate abrasive dispenser **14**. FIG. **5**C is a schematic orthography back view of the spray nozzle actuator assembly **55** of the aqueous-based particulate abrasive dispenser **14**. FIG. **5**D is a schematic back view of the spray nozzle actuator assembly **55** of the aqueous-based particulate abrasive dispenser **14**. FIG. **5**E is a schematic side view of the spray nozzle actuator assembly **55** of the aqueous-based particulate abrasive dispenser **14**.

Although alternatives are possible, the spray nozzle **15** is connected to an actuator shaft assembly **46** and the spray nozzle **16** is connected to an actuator shaft assembly **47**. The actuator shaft assembly **46** and the actuator shaft assembly **47** are connected to a spray nozzle actuator assembly **55** via a belt drive assembly **49**. The belt drive assembly **49** is coupled to the actuator shaft assembly **46** and the actuator shaft assembly **47** via a gear shaft **50**. The spray nozzle actuator assembly **55** can comprise a rotary motor arrangement including one or more rotary motors. The spray nozzle actuator assembly **55** can adjust a spatial attribute, such as a position or orientation, of the spray nozzle arrangement **21**. The spray nozzle actuator assembly **55** is connected to a first end of the gear shaft **50**. When activated, the spray nozzle actuator assembly **55** moves the gear shaft **50** in a circular motion, which rotates the belt drive assembly **49** along its path. As the belt drive assembly **49** rotates, the belt drive assembly **49** causes the actuator shaft assembly **46** and the actuator shaft assembly **47** to rotate via gear assembly **51** of actuator shaft assembly **46** and gear assembly **52** of actuator shaft assembly **47**.

The actuator shaft assembly **46** includes an adjustable pivot **65** and the actuator shaft assembly **47** includes an adjustable pivot **66**. The adjustable pivot **65** and the adjustable pivot **66** adjustably angle the actuator shaft assembly **46** and the actuator shaft assembly **47** to convert the rotational motion of the gear assembly **51** and **52** to eccentric oscillating motion at the spray nozzle **15** and the spray nozzle **16**. Because the adjustable pivot **65** and the adjustable pivot **66** are adjustable, the amount of eccentric motion (e.g., the magnitude of the approximate circular motion of the spray nozzles) generated at the spray nozzle **15** and the spray nozzle **16** can be adjusted.

Although alternatives are possible, the spray nozzle **15** and the spray nozzle **16** can be both horizontally offset and vertically offset from one another. For example, the spray nozzle **15** and the spray nozzle **16** can be disposed above and to a side of the spray nozzle **16**. In some embodiments, the positions of the spray nozzle **15** and the spray nozzle **16** relative to one another are coordinated with the motion generated by the spray nozzle actuator assembly **55** so that the regions on the target that are sprayed by the spray nozzle **15** and the spray nozzle **16** abut one another.

The aqueous-based particulate abrasive dispenser **14** can also include an extension assembly **45**. The extension assembly **45** can selectively adjust how far the spray nozzle arrangement **21** extends out from the aqueous-based particulate abrasive dispenser **14**. For example, the extension assembly **45** can comprise a pneumatic arm that positions the spray nozzle **15** and the spray nozzle **16** closer to or further from the target. In some examples, the extension assembly **45** causes the spray nozzle **15** and the spray nozzle **16** to extend further out from a front surface **48** of the aqueous-based particulate abrasive dispenser **14**. Alternatively, the extension assembly **45** causes the aqueous-based particulate abrasive dispenser **14** as a whole to move forwards or backwards along a rail assembly **56**. Although alternatives are possible, in the example shown, the aqueous-based particulate abrasive dispenser **14** is disposed on the rail assembly **56** with linear motion bearings **57**, **58**, **59**, and **60**.

It is noted that throughout this document, some applications of the equipment in order to cause spray but without aberration of concrete necessarily occurring, has been described. Referring to FIG. **5**E at SN, additional spray nozzles are shown that can be used to conduct such a rinse and/or to remove materials such as uncured concrete end or wax from the concrete surface. These can be fed with water from a pressure washer system **20**, but without abrasive contained therein. FIGS. **6**A-**6**D are schematic illustrations of the vertical guide rail assembly **17**. FIG. **6**A is a schematic orthographic view of the vertical guide rail assembly **17**. FIG. **6**B is a schematic back view of the vertical guide rail assembly **17**. FIG. **6**C is a schematic top view of the vertical guide rail assembly **17**. FIG. **6**D is a schematic side view of the vertical guide rail assembly **17**.

In addition to the components of the vertical guide rail assembly **17** that have been previously described, the vertical guide rail assembly **17** includes a bearing assembly **61**, pulley assembly **62**, bearing assembly **63**, and bearing assembly **64**. The bearing assembly **61**, the bearing assembly **63**, and the bearing assembly **64** allow for linear movement. Although alternatives are possible, the bearing assembly **61**, bearing assembly **63**, and bearing assembly **64** each include one or more linear motion bearings. The bearing assembly **63** connects the vertical guide rail assembly **17** to the upper guide rail assembly **30** of the horizontal guide rail assembly **18** and allows the vertical guide rail assembly **17** to move along the upper guide rail assembly **30**. Similarly, the bearing assembly **64** connects the fp**17** to the lower guide rail assembly **31** of the horizontal guide rail assembly **18** and allows the fp**17** to move along the fp**31**.

As shown in these figures, the enclosure **38** is coupled to the rail assembly **36** and rail assembly **37** via the bearing assembly **61**. Although alternatives are possible, the enclosure **38** is shown as connected to a pulley assembly **62** that can move the enclosure **38** up and down vertically along the rail assembly **36** and rail assembly **37**. For example, the pulley assembly **62** may be actuated by the vertical position adjustment system **35** (not shown in FIGS. **6A-6**D).

FIG. **7** is a schematic illustration of example spray material dispensing equipment **70**. The spray material dispensing equipment **70** is an example of the dispensing equipment arrangements **6**, **7**, **8** shown in FIG. **1**. Various embodiments of the system **1** may include more or fewer than three of the spray material dispensing equipment. As shown, the spray material dispensing equipment **70** is adapted from ECO-QUIP EQ600s vapor abrasive blast equipment from Graco, Inc. of Minneapolis, Minn. 55413. The spray material dispensing equipment **70** can be adapted from other equipment, however.

II. Example Control Equipment, FIGS. **8-15**

FIG. **8** is a schematic illustration of the control equipment **5**. The control equipment **5** controls the operation of at least some of the components of the sprayer system **1**. The control system can send control signals to the components using any communication technology including wired and wireless technologies. In this example, the control equipment **5** includes a local computing device **75** and a server **76** that communicate over a network **77**.

The local computing device **75** may be a personal computer or any other type of computing device. In some aspects, the local computing device **75** includes a touch screen and a reader. The local computing device **75** includes an equipment control engine **78** that controls the operation of the material communication assembly **3** and the dispenser positioning arrangement **4**.

The equipment control engine **78** may access job specific parameters about a target from a job database **79** on a server using a job identifier. In some embodiments, the equipment control engine **78** receives the job identifier from the reader. The reader reads a job identifier from an identifying element associated with a target (e.g., architectural precast concrete wall panel). The identifying element may be, for example, a barcode or an RFID tag.

Otherwise, an operator may enter the job identifier via a user interface generated by the equipment control engine **78** using a user input device on the local computing device **75**. For example, the user may select the job identifier by touching a region of the touch screen (e.g., such as an entry in a list of jobs). Alternatively, the operator may type in the job identifier using a physical or virtual keyboard.

Example User Interfaces of the Control Equipment

FIGS. **9-14** illustrate example user interfaces generated by embodiments of the equipment control engine **78**, which may be displayed on a display device of the local computing device **75**.

FIG. **9** is a schematic illustration of a job identifier selection screen **100**. The job identifier selection screen **100** includes a list **101** that includes a plurality of job identifiers. An operator can select a particular job identifier to load the associated job parameters. The job identifiers that are displayed may be retrieved from the job database **79**. In some embodiments, the displayed job identifiers are retrieved based on a job date that is stored in the job database **79** and associated with the retrieved job identifiers. For example, all job identifiers that are associated with a particular job date may be displayed in the list **101**. In some embodiments, completed jobs are not shown on the panel either (e.g., the job database **79** may store a status field associated with each job identifier).

FIG. **10** is a schematic illustration of a setup screen **102** that displays parameters for a job. The parameters may be loaded from the job database **79** based on the job identifier. In some embodiments, an operator may then adjust the parameters by actuating (e.g., touching, clicking with a mouse) user-actuatable interface elements **103**.

FIG. **11** is a schematic illustration of a job display screen **104** that displays an illustration of a particular job and target. The job may divide the target into multiple regions, which will be subject to different job parameters. In this example, the target **105** includes a first region **106** and a second region **107**. The first region will be subject to job parameters to produce a light texture, while the second region will be subject to job parameters to produce a medium texture. Also shown are cutouts **108** and **109** in the target **105**. These cutouts may be for windows and doors. In some embodiments, the cutouts are not subject to any treatment. Various color or shading schemes may be used to identify the job parameters that will be applied. In this example, the job display screen **104** includes a legend **110** to explain the relationship between a displayed color and the job parameters.

During operation, the system **1** may generate the light texture on the first region **106** before generating the medium texture on the second region **107**. Prior to the system **1** operating on the first region **106**, the operator may place a protective structure/surface over some or all of the second region **107** so that it is protected from the activities occurring with respect to the first region. For similar reasons, after the system **1** is done with the first region **106** and before the system **1** starts on the second region **107**, the operator may move the protective structure over to the first region.

FIG. **12** is a schematic illustration of a job display screen **111** that shows an in-process job, including the position of the dispensing equipment, the job parameters, and the time remaining in the job. The screen also displays the amount of material remaining in the dispensing equipment. In some embodiments, if the dispensing equipment has an insufficient quantity of material to complete a job, the job is not started.

FIG. **13** is a schematic illustration of an advanced setup access screen **112**. The operator may need to enter a code using a displayed keypad **113** to access the advanced setup screen.

FIG. **14** is a schematic illustration of an advanced settings screen **114** that allows an operator to adjust default settings for texture levels (e.g., light, medium, and heavy). Although alternatives are possible, in this example, the advanced settings screen **114** can only be accessed by an operator after access has been granted via the advanced setup access screen **112** (shown in FIG. **13**).

Example Computing Device of the Control Equipment

In FIG. **15**, a schematic view of the physical components of an example **90** a computing device, such as the local computing device **75** or the server **76**, is shown. As illustrated, the device includes at least one processing device **80**, such as a central processing unit ("CPU"), a system memory **81**, and a system bus **82** that couples the system memory **81** to the processing device **80**. The system memory **81** includes a random access memory ("RAM") **83** and a read-only memory ("ROM") **84**. A basic input/output system containing the basic routines that help to transfer information between elements within the device, such as during startup, is stored in the ROM **84**. The device further includes a computer-readable data storage device **85**. The computer-readable data storage device **85** is able to store software instructions and data.

The computer-readable data storage device **85** is connected to the processing device **80** through a storage controller (not shown) connected to the bus **82**. The computer-readable data storage device **85** and its associated computer-readable data storage media provide non-volatile, non-transitory storage for the device. Although the description of computer-readable data storage media contained herein refers to a mass storage device, such as a hard disk or CD-ROM drive, it should be appreciated by those skilled in the art that computer-readable data storage media can be any available non-transitory, physical device or article of manufacture from which the device can read data and/or instructions.

Computer-readable data storage media include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable software instructions, data structures, program modules or other data. Example types of computer-readable data storage media include, but are not limited to, RAM, ROM, EPROM, EEPROM, flash memory or other solid state memory technology, CD-ROMs, digital versatile discs ("DVDs"), other optical storage media, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by the device.

According to various embodiments of the invention, the device may operate in a networked environment using logical connections to remote network devices through the network **77**, such as a local network, the Internet, or another type of network. The device connects to the network **77** through a network interface unit **86** connected to the bus **82**. The network interface unit **86** may also be used to connect to other types of networks and remote computing systems. The device also includes an input/output controller **87** for receiving and processing input from a number of other devices, including a keyboard, a mouse, a touch user interface display screen, or another type of input device. Similarly, the input/output controller **87** may provide output to a touch user interface display screen, a printer, or other type of output device.

As mentioned above, the computer-readable storage device **85** and the RAM **83** of the device can store software instructions and data. The software instructions include an operating system **88** suitable for controlling the operation of the device. The computer-readable storage device **85** and/or the RAM **83** also store software instructions, that when executed by the processing device **80**, cause the device to provide the functionality of the device discussed in this document. For example, the computer-readable storage device **85** and/or the RAM **83** can store software instructions, such as software applications **89** that, when executed by the processing device **80**, cause the device to perform as described herein.

III. General Comments and Observation

According to the present disclosure a method of providing a surface portion of an architectural precast concrete wall panel with an abraded texture is provided. The method includes a step of spraying a surface portion of an architectural precast concrete wall panel with an aqueous-based particulate abrasive mixture under conditions adequate to at least partially abrade the surface portion.

Another aspect provided by the present disclosure is a sprayer system for abrading a concrete surface. The system includes an aqueous-based particulate abrasive mixture dispenser including a spray nozzle arrangement. The system also includes a material communication assembly in abrasive flow communication with the aqueous-based particulate abrasive mixture dispenser. The system also includes a dispenser positioning arrangement.

Yet another aspect provided by the present disclosure is an aqueous-based particulate abrasive mixture dispenser apparatus for abrading a concrete surface. The apparatus comprises a vapor abrasive material receiver. The apparatus further comprises a spray nozzle arrangement connected to the vapor abrasive material receiver. The apparatus also comprises a spatial attribute adjustment motor assembly that is connected to the spray nozzle arrangement.

Another aspect provided by the present disclosure is a method of retrofitting an architectural precast concrete wall panel factory to use a sprayer system for preparing a concrete surface. The method includes the step of positioning a framework in a spray chamber of the factory, the framework including a horizontal guide rail assembly and an installation support structure connected to the horizontal guide rail assembly. The method also includes the step of mounting the horizontal guide rail assembly to an overhead support structure. The method also includes the step of removing the installation support structure.

As indicated above, in general, the techniques described herein can be used in situations, in which an aggressive washing of a precast concrete surface is desired. Examples are described in which washer nozzles are included in the equipment that also include nozzles and equipment for abrasive application. Such washers can be used, for example, when the concrete has a wax material thereon at selected locations, or when it has uncured sections of concrete that are to be removed.

What is claimed:

1. A method of providing a surface portion of an architectural precast concrete wall panel with an abraded texture, the method including a step of:

receiving, in a spray chamber of a factory, an uninstalled architectural precast concrete wall panel formed from cement and aggregate and having a thickness of at least three inches;

selecting or defining a predetermined texture to be abraded into a selected surface portion of the architectural precast wall panel with an aqueous-based particulate abrasive mixture by:

defining a motion path for controlling the motion of a dispenser; and

defining one or more selected speeds of the dispenser along the motion path; and

spraying the selected surface portion of the architectural precast concrete wall panel with the aqueous-based particulate abrasive mixture from the dispenser along the motion path at the one or more selected speeds and pressures to at least partially abrade the selected surface portion to provide the predetermined texture.

2. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises sufficiently abrading cement of the architectural precast concrete wall panel to expose aggregate in a selected portion of the surface portion.

3. A method according to claim **2**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises abrading the selected portion such that no greater than 25% of the selected portion is sufficiently abraded to expose aggregate embedded in the architectural precast concrete wall panel.

4. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises spraying an aqueous-based particulate abrasive mixture having, by volume, at least 50 parts of particulate abrasive to 1 part of liquid.

5. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural concrete wall panel comprises spraying an aqueous-based particulate abrasive mixture formed from a liquid having no acid added thereto.

6. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural concrete wall panel comprises spraying an aqueous-based particulate abrasive mixture having a pH of at least 6.

7. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises spraying an aqueous-based particulate abrasive mixture comprising at least 95% by weight particulate abrasive sized to pass through a mesh of mesh size of at least 4 openings per linear inch.

8. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises spraying an aqueous-based particulate abrasive mixture comprising crushed glass.

9. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises spraying an aqueous-based particulate abrasive mixture comprising garnet.

10. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises spraying an aqueous-based particulate abrasive mixture comprising sand.

11. A method according to claim **10**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises spraying an aqueous-based particulate abrasive mixture comprising sand and garnet.

12. A method according to claim **1**, further comprising a step of:

moving an aqueous-based particulate abrasive mixture dispenser across the surface portion of the architectural precast concrete wall panel.

13. A method according to claim **12**, further comprising a step of:

moving the architectural precast concrete wall panel to a position in front of the aqueous-based particulate abrasive mixture dispenser, wherein the panel has a perimeter area of at least forty square feet.

14. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises:

spraying a first region of the surface portion using first dispensing settings; and

spraying a second region of the surface portion using second dispensing settings that are different than the first dispensing settings.

15. A method according to claim **1**, wherein the step of spraying the surface portion of the architectural precast concrete wall panel comprises spraying the first region using a first horizontal movement speed setting and spraying the second region using a second horizontal movement speed setting that is different from the first horizontal movement speed setting.

16. A method of retrofitting an architectural precast concrete wall panel factory to use a sprayer system for preparing a concrete surface, the method including a step of:

positioning a framework in a spray chamber of the factory, the framework including a horizontal guide rail assembly and an installation support structure connected to the horizontal guide rail assembly;

mounting the horizontal guide rail assembly to an overhead support structure; and

removing the installation support structure.

17. The method of claim **1**, further including the step of:

defining one or more selected pressures for dispensing an aqueous-based particular abrasive mixture from the dispenser.

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